THE JOURNAL OF THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

VOLUME THE SEVENTH.

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LONDON:
JOHN MURRAY, ALBEMARLE STREET.

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MISCELLANEOUS COMMUNICATIONS AND NOTICES:—

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ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

I.—*On the Condition of the Agricultural Labourer; with Suggestions for its Improvement.* By George Nicholls.

Prize Essay.

This is one of the questions proposed by the Society as the subject of an Essay, and it must be admitted that none can be of greater interest and importance. The condition of the whole community depends upon that of its several parts, and the agricultural portion forms so important a part of the entire British community, that too much attention cannot be paid to its condition by individuals of every class, and more especially by the owners and occupiers of land, with whom the labourer comes into daily contact, and upon whom he may be said to depend for obtaining the daily means of support.

That the condition of our agricultural labourers is not in all respects what it ought to be, must at once be admitted. Indeed it is implied in the question proposed by the Society; for if their condition were altogether satisfactory, means for its improvement need not now be so sedulously sought after. This admission must not, however, be taken to imply more than that the present condition of the agricultural labourer, in common with the condition of the labouring class generally, is such as to invite the efforts of the more affluent for its amelioration. With all there is much to improve, much to be amended; and this will not be denied by any one who has had extensive opportunities of observing the condition of the working classes. There is, it is true, nothing new or peculiar in this state of things. Poverty, with its attendant privations, always has existed, and always will exist; but whilst compelled to bear with its existence, we are at the same time bound to do all that we can to lighten its pressure and mitigate its evils.

The general condition and habits of our labouring population at different periods would form an extremely interesting subject of inquiry, and if it were properly conducted, it would enable us to judge how far their present condition is improved or otherwise, as compared with their condition at any antecedent period. But to afford the means of accurate judgment on this point, the inquiry must extend to every class, in order that the relative position of the working class might be seen, as well as its actual position—relatively with respect to other classes, and actually as respects itself. There is neither time nor space for such an inquiry at present, but it may be well to notice very briefly two or three facts bearing upon the question.

The average duration of life, or what is called the probability of life, may be regarded as pretty certainly indicating the condition of a people; and measured by this test, there appears to have been a marked improvement in the condition of the English people in course of the last century, the probability of life having greatly increased within that period. It is now, according to the Registration Returns, forty-one years, whilst between 1735 and 1780 it was estimated by Dr. Price at only twenty-five years, and other statists had estimated it at considerably less in the century preceding. It is true that at those early periods the estimates were founded upon less perfect data than what we now possess, and are most likely to some extent erroneous; but they serve to show that the average duration of life has been progressively increasing, and we may infer that the increase has been a consequence of the generally improved condition of the people.

So in regard to the laws chiefly affecting the lower orders. The severity of these laws has been materially mitigated of late years, most of the harsher penalties having been abolished, and the others so modified as to deprive them of the severe and revolting character which they previously bore. There is still, it is true, something to be done in this respect, of which the legislature appears fully sensible, a session seldom passing without some enactment expressly directed to this object.

So likewise as regards the relief of the destitute. The means provided for this purpose are more ample, and better organised, than at any preceding period. More money may heretofore have been expended, but the amount of relief afforded to the really destitute has never been so ample nor so accessible as at present, neither were the sick poor ever so well cared for.

Having regard then to the increase in the duration of life, and to what has been done to lighten the pressure of the penal laws, and to ensure the administration of adequate relief to the really destitute poor, it seems impossible to doubt that the condition of the working classes in this country has been improved, and that it

is now on the whole actually better than it was thirty, fifty, or a hundred years ago.

It is true that the extension of trade and manufactures, and the increase of wealth, have added greatly to the enjoyments of the middle and higher classes, and it may be doubted whether there has been a corresponding increase in the enjoyments of the working class. The social fabric has been enlarged; it has more stories, more gradations, but the lowest still remains nearly at its former level. This may perhaps be in some measure unavoidable, and so long as due harmony and coherence prevail throughout, the fabric will stand secure; but it cannot be deemed secure if there be wide breaks in its gradations, or a want of proper sympathy among its several parts. To perpetuate this harmony if it already exists, and to restore and establish it if it be wanting, constitute the high privilege of the statesman and the patriot.

History affords no parallel to the rapid accumulation of wealth in this country within the last half-century, and the growth of our population has fully kept pace with it. By the census returns of 1801 the population of Great Britain was then 10,942,646; whilst by the last census, that of 1841, it was 18,844,434; showing an increase of two-thirds, or nearly eight millions, in forty years. We have no means of ascertaining the increase of capital within the same period, but it may be pretty well inferred from the Property and Income Tax Returns. Those for 1815 give the amount assessed in England and Wales at 51,790,879*l.*, and those for 1843 give the amount at 85,802,735*l.*; and if we assume that the rate of increase was about the same throughout the whole period as we find it to have been between 1815 and 1843, it would make the income liable to assessment in 1801 amount to about 41,000,000*l.*, and show that it had more than doubled in the last forty years. This vast increase of wealth has no doubt chiefly arisen from the energy and enterprise of the commercial portion of the people, whom it has elevated to a position of great comparative importance; but it has likewise been greatly aided by the improvements in agriculture, which have largely sympathised with, if they have not fully kept pace with our manufacturing improvements. Each has acted and reacted on the other, each being in fact essential to the other.

With more capital at command and more intelligence in its application, with improved methods of cultivation and better means of communicating with distant markets, the farmer was enabled and naturally wished to occupy more land; and it was also natural that the landlord should be desirous of meeting his wishes in this respect. Hence the frequent consolidation of small farms into farms of larger extent, doubtless to the general benefit

by the increase of produce to which it has given rise: but at the same time, it must be admitted, without a corresponding improvement in the condition of the agricultural labourer. Indeed upon him it has had a contrary effect, for the application of more capital and skill to the purposes of cultivation, and the consequent increase in the size of farms, have tended to increase the distance between the farmer and the farm-labourer, elevating the one and relatively depressing the other.

The consolidation of farms, by lessening the number of tenant farmers, and especially those of the smaller class, has moreover increased the difficulty to the labourer of emerging from his position and rising into a higher grade. However industrious and provident, however skilled in the ordinary occupations of husbandry, he can now hardly hope to raise himself by his own efforts to the condition of a small tenant farmer. He may by good conduct rise to the top of his class, and become head ploughman, head carter, or barnsman; but he is still a day labourer, and, with a few rare exceptions, is practically restricted from rising higher.

Such being the case with the agricultural labourer—the consolidation of farms, although it has not lessened the fund applicable to the payment of wages, nor made the labourer's condition *actually* worse, has made it so *relatively*, and rendered his chance of rising by his own exertions more remote. Since such is the case with this numerous and most valuable class of men, on whose industry and integrity the profits of the farmer and the security of agricultural property so mainly depend, it is surely our duty to impart all the improvement of which the labourer's condition is susceptible, to strive to increase his comforts, and to endeavour by every means in our power to make him happy and contented in his position.

It is, however, essential that whatever is done in furtherance of this object should be in accordance with sound principle, for unless this is attended to, much evil may be inflicted where good only was intended. Anything which tends to divert or weaken the labourer's reliance upon his own exertions for the support of himself and his family, or that leads him to rely habitually upon others, will prove injurious to him in the end. By this governing principle every scheme must be tested, and whatever militates against it, however promising it may appear at the moment, should at once be abandoned as unsafe, if not actually pernicious. Happily much may be done within the limits of this principle by the judicious landlord and the intelligent farmer, for increasing the comforts and improving the condition of their labourers; and some of the means for accomplishing these objects will be hereafter stated.

No one will deny that the labourer is as necessary to the employer, as the employer is necessary to the labourer—each is in fact essential to the other, and the kindliest feelings should be mutually cultivated between them. On the part of the employer this will be at once easy and delightful. By promoting the comfort of his people he will secure their confidence, and obtain the services of the heart as well as of the hands. His interest will become their interest. and they will watch over and promote it with a zeal proportionate to that which he evinces in promoting their welfare. A little done in this way will ensure a large return, if it be done in a frank and kindly spirit; but there must be nothing derogatory to the recipients, either in the thing done or in the manner of doing it. Whatever it be, it must appear to emanate from a desire for their benefit. If any other motive be apparent, no responsive feeling will be awakened. The people are quick in reading motives, and not always prone to interpret them favourably; but their confidence once obtained, they are easily led, especially when they find their own comforts increasing under the guidance.

Having made these few introductory observations. I will now proceed to the immediate subject of consideration, as it has been proposed by the Society, namely, "the improvement of the condition of the agricultural labourer, so far as it may be promoted by private exertion without legislative enactment." This question may, I think, be most conveniently dealt with under the four following heads of recommendation, viz. :—1st. To enlarge the field of labour; 2nd. To extend the benefits of education; 3rd. To provide comfortable cottages; 4th. To provide cottage gardens. Under one or the other of these heads, or under the whole of them collectively, all or nearly all which can with safety be done for improving the condition of the agricultural labourer, may, I believe, be comprised.

1st.—*To enlarge the Field of Labour.*

To increase the demand for labour, by enlarging the field of its application, will necessarily lead to an increase of the means of living for the labouring class. Of course profitable labour is here meant, labour that will yield a return to the employer; for labour that is profitless, or altogether forced and artificial, cannot be relied upon for affording permanent means of subsistence to the labourer. It is only from the profits of labour that the fund for the payment of wages can be permanently obtained.

That the field of profitable labour in this country is susceptible of being enlarged, is universally admitted. The agricultural produce of England might probably be increased one-third by the application of more capital and more labour to the cultivation of

land, and if the capital were judiciously applied it would be abundantly remunerative. In Ireland the produce might probably be doubled by like means. Under these circumstances, there can be no insuperable difficulty in extending the field of labour fully up to what is required for affording employment to the whole of the agricultural population; and our great landowners and capitalists ought to apply themselves towards the accomplishment of this object, by originating and carrying forward improvements, in conformity with the advanced science and intelligence of the day. If they will do this, the field of labour will speedily be enlarged, and improvement in the condition of the working classes will accompany its enlargement.

In trade and manufactures improvements are now being daily introduced, and often at a vast outlay of capital, in order to keep pace with the intelligence and wants of the times; and why should not the same principle of progression be applied to agriculture? There is no lack of inducements. Our agriculturists would find their own interest promoted by it, in common with that of their labourers and of all others engaged in or connected with agricultural pursuits. Indeed the interests of the whole community would be promoted, for by increasing the produce of the land the general wealth of the country would be increased, and every interest would thus be served through the instrumentality of the landed interest, which would itself, however, derive the largest share of the benefits resulting from its own efforts.

It is not here intended to discuss the several improvements of which farming operations are susceptible. These are set forth in the Journal of the Society, and in various other publications of merit and authority; all serving, however, to establish the fact, that there is a wide field for improvement open to the agriculturists of the present day, and that one of the chief elements required is the application of an increased amount of labour.

Every farmer is aware that nothing pays better than labour, that there is no substitute for it, and that without it nothing which can be applied to the land will yield a profitable return. Yet how often does the farmer fail to employ the necessary amount of labour, whilst his land is left foul with weeds, undrained and imperfectly cultivated, with waste patches covered with rubbish but capable of yielding valuable produce, with fences extending over three or four times the space they ought to occupy, with a farm-yard wasting the manure which ought to be carefully preserved for fertilizing the land, with his farm half stocked, half worked, the labourers in a state of poverty, their cottages poor and comfortless, without a garden or anything to render them cheerful and attractive. This is not an overdrawn picture—it exists in too many instances in every part of the

country; and to this state of things the landowners of England are called, alike by a sense of public duty and a regard for their own interest, to endeavour to apply a remedy.

Every English landlord will admit that property has its duties as well as its privileges, and he ought not to be backward in acting up to the principle which the admission involves. He must not only do whatever may be necessary himself, but he must likewise exert his influence with his tenantry, and lead them to adopt improved methods of cultivation, affording them at the same time all proper assistance and encouragement, and assuring to them the full enjoyment of the fruits of their outlay. The good effect of a landlord's so acting, would soon be witnessed in the improved appearance of the farm, and in the increase of employment and improved appearance of the labourers, whilst himself and the public would be benefited by the increase in the produce of the soil.*

The landlord's influence ought likewise to be exercised for bringing about a change in another important respect. The practice of keeping young men as yearly servants in the house with the farmer, was heretofore universal; and the discontinuance of this practice of late years, has been productive of much mischief and demoralization. Towards young men so employed, the farmer stood in the relation of a parent. They formed a part of his family. To him they were accountable. To him they were accustomed to look for advice. And they were thus kept out of the way of temptation, and prevented from falling into idle and improvident habits, to which all young men are more or less prone if left without control. Our farmers now rarely employ yearly servants of this description. They generally engage their labourers by the day, by the week, or by the job, taking no further care about them, and leaving them, whether single or married, to provide for themselves as they best can. The consequence is that young men are now for the most part left without supervision of any kind. Their parents' cottage is almost always too small to accommodate them. They struggle for a time against its discomforts, and against the bickerings and disagreements to which these frequently give rise; and they then quit the parental roof, and take refuge in some lodging-house, occupied probably by other young men of their own class.

Can youths and young men so cast upon the world, loosened from all control, and subjected to vicious promptings and the temptations of their own animal passions—can young men so situated, often uneducated and without the benefit of religious training, be expected to exercise forethought and self-restraint

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* See note A, at the end.

either in the all-important affair of marriage or in anything else to which they may be prompted by their fancy or their passions? —Would it be reasonable under such circumstances to look for sober, steady, industrious habits?—Must not, on the contrary, such a state of things tend to destroy the better feelings of our nature, and to brutalise the whole rural population?—Such, it is feared, must too surely be the consequence of thus leaving the young unmarried agricultural labourers without supervision or control; and the remedy appears to lie in a return to the old practice, of every farmer engaging a number of yearly servants, according to the size and circumstances of his farm, to reside with him in the house under his own immediate inspection. This would in fact be enlarging the field of labour, by rendering it continuous to the individuals so engaged; whilst it would restore a very important link in the social chain, which circumstances have of late years tended to weaken. It would moreover help to prevent improvident marriages, and would conduce in various ways to improve the habits and condition of the labouring class, whilst it operated at the same time beneficially for the farmer.

Seeing the evils arising from youths and young men being thus left without control, one of our large landowners (whom for obvious reasons I omit to name) has adopted the practice on his estate of placing a certain number of the best conducted youths with the head workmen, who take charge of them, and exercise a kind of parental authority over them. They reside with the foreman at the homestead, and are provided with board, washing, and mending, at a moderate charge. A small library is formed for their use and that of the other labourers, and the whole is under the immediate superintendence of the farm bailiff. This is perhaps the nearest approximation to the old practice which circumstances admit of, and is earnestly recommended for adoption where the owner farms his own land, or where the farms are sufficiently large to admit of it. In the majority of instances, however, this plan will perhaps not be applicable; and the only effectual remedy for the evil in such cases will be, to return to the old practice of each farmer keeping a certain number of youths and young men, as yearly servants, under his own roof.

Our landowners ought, moreover, to use their influence for changing another practice that now operates injuriously to the labourer, and by altering which the field of employment would be practically enlarged, whilst both the farmer and the labourer would be benefited—namely, by making employment more certain and continuous, by doing away with those breaks in his engagement to which the labourer is now often subjected, and employing him permanently throughout the year. There can be no doubt that the labourer's earnings within the year, however

he may be employed, ought to be sufficient to support him throughout the year; and the farmer should endeavour so to form his arrangements as to keep his labourers always in work, since they must be always maintained. It is certain he cannot do without them for a large portion of the year; and if he discharges them when they are less wanted, they must still be maintained in some way, and towards their maintenance the farmer must in some shape contribute. Would it not then be better for him to keep them continuously at work, which, although it might not be altogether remunerative, would yet be so to some extent, rather than have to contribute towards their support without deriving any return whatever?

This is the economical view of the matter; but the question is of far greater importance when viewed with reference to its moral consequences. To discharge labourers at every trick and turn, tends to break up the kindly relation which ought ever to subsist between master and servant. Can the labourer be expected to feel attachment to the person or regard for the interest of an employer, who, the moment it becomes possible to do without him, will, he knows, throw him upon the union for support? Can that kindly confidence exist between them, which ought always to exist between persons so intimately connected and mutually dependent? Does not their position, in fact, become in some sense antagonistic, and of a nature to awaken evil passions, tending to the demoralization of the labourer and the injury of the employer? Must not a good industrious workman feel it a great hardship, if not a positive injustice, to be cast upon the parish or the union during the slack season of the year, instead of being enabled to live throughout the year by the fruits of his own honest labour?— These are questions of deep interest to every owner and occupier of land, whom it behoves carefully to consider their tendency and import.

Some landlords, actuated by the best spirit, have endeavoured to supply a remedy for the evil above adverted to, by giving employment at moderate wages during the slack months to all who apply for it. This has been attended with very satisfactory results, and is an example worthy of being followed: but the landlord's influence ought at the same time to be exercised among his tenantry, to induce the farmers to provide permanent employment, and to keep their labourers at work throughout the year. This would establish a durable connexion between them, but such connexion, and the attachment naturally springing out of it, cannot exist if the labourer is turned adrift the moment he can be dispensed with; and the sooner this practice is abandoned, and continuous employment provided, thereby restoring the natural dependence of the servant on the one hand, and the natural influ-

ence of the master on the other, the better will it be for both, and for the whole community.

To improve the cultivation of the land by the application of as much capital and as much labour as can be profitably employed upon it, and to take advantage of the inventions of mechanical and the investigations of chemical science, is a certain way to improve the condition of every class connected with agriculture—of the owner and occupier by increased produce, and of the labouring class by a more extended field for the exercise of their industry, and an increase of the fund applicable to wages. One improvement naturally leads to another, all operate in the same direction, and conduce to the general welfare; and to neglect improvement is therefore a common injury. This truth cannot be too thoroughly inculcated upon every class. It is the common bond of union and social progression. All are alike interested in understanding and acting upon it—the landlord as well as the tenant, the farmer as well as the labourer, and the agricultural class no less than the commercial class.

In stating this as a general truth applicable to every class, it must however always be borne in mind, that the duty of acting upon it and carrying it out to its legitimate results, devolves chiefly upon the most intelligent and influential class—that is, upon the educated and owner class, by whom the privileges of property are chiefly enjoyed, and who are bound therefore to be forward in fulfilling the duties which its possession imposes. One of the first of these duties is to promote the comfort and attend to the well-being of the several classes subordinate to them, by whose industry their own comforts are provided, and by whose labours their property is rendered productive; and this duty is more especially imperative as regards the owner of land, his subordinates of every grade being in a peculiar manner subject to his influence and control. The proprietor of a large domain may be said to be almost absolute within its limits. If the land be imperfectly cultivated, the tenants poor and ill-informed, and the labourers in a bad condition—wherever these evils prevail, they must be regarded as proofs of the landlord's incompetency or neglect; whilst, on the other hand, well-cultivated farms, a thriving tenantry, and orderly and well-conditioned labourers, afford proof that the landlord has exercised the rights and the influence of property judiciously, by stimulating improvement and encouraging and assisting his tenantry to apply more capital and more labour to the land, by means of which the field of employment has been enlarged, and the tenants themselves benefited.

It may possibly be here objected, that too great a responsibility is cast upon the owners of property, and that too much is required

from landlords. It may perhaps be further said, that the spirit of improvement which is abroad, and the emulation and energy which accompany it, will be sufficient for effecting all that is necessary, without the landlord's intervention or extraneous helps of any kind. Experience does not, however, bear out this last proposition, or there would be less in the way of improvement to be effected at the present day. And with respect to the first objection it may be answered, that as the value of property is increased by all improvements, they ought to originate with the owner as well as to be supported by him. This will accordingly be found to have been the case; most of the improvements, certainly all the material improvements of late years, having originated with and been carried forward by individual landlords, such as the late Duke of Bedford, Mr. Coke of Norfolk, and others who still remain among us, and whose great merits in this respect are now fully appreciated. But for the exertions of these eminent persons in their capacity of landlords, the improvements which they originated would not have taken place, at least not at so early a period, neither would they have been carried out so effectively or been so extensively adopted. On the score of example, then, as well as of self-interest and a sense of public duty, our landlords have every inducement to attend to the improvement of their property, with which, if it be judiciously conducted, their tenants and labourers and all connected with them will abundantly sympathise.

2nd.—*To extend the Benefits of Education.*

That ample means for the education of the working classes should be provided is now universally admitted, although there may be some difference of opinion as to the nature of the education, and the extent to which it ought to be carried. Whatever may have been the case formerly, no one in the present day ventures to assert that the working classes should be reared in ignorance, or that knowledge as well as wealth should be the portion of the higher classes alone; and accordingly there is now a stronger disposition to promote the education of the lower orders than has probably ever existed before, at least since the time of Edward VI. Still, however, opinions are by no means unanimous as to what the nature of the education ought to be—some contending for a wider, some for a narrower range of instruction.

There can be no doubt that mankind, in the aggregate, will be that which they are taught and trained to become; and it follows that they should be so taught, so trained, as to fit them in all respects for the duties which they will have to perform, and for the station of life in which they are, or in which they may eventually be placed. This ought to be the great object of education—

this alone can be called '*good education.*' All that is beyond it may be considered, to a certain extent, unnecessary; and whatever falls short of it must certainly be looked upon as defective.

In thus stating the question, it must not however be overlooked, that whilst to fall short of the requisite amount of education in any case is a positive evil—an injustice to the individual, and an injury to the community—an excess of education does not entail similar consequences, is not an evil, injures no one, and may even become in certain cases a good, by enabling an individual to avail himself of favourable circumstances for improving his condition and rising in life. In arranging a system of education for the working classes, we ought therefore to guard against falling short in its quality and extent, rather than against carrying it to excess, in which there is in truth nothing to apprehend, so long as it is accompanied by proper moral and religious training.

Whatever may be the nature of the education in other respects, it must always be a matter of chief consideration to imbue the youthful mind with a deep sense of religion, to teach the duty we owe to God and man, and to impress upon young persons of both sexes a strong conviction of the benefits to be derived from habits of temperance, industry, and forethought in their progress through life. The inculcation of these moral and religious duties constitutes the groundwork of all good education, the basis on which the superstructure of secular knowledge is to be raised, and without which it would be insecure and comparatively valueless.

The lesson that abstinence leads to future abundance, cannot be too early taught to the young, nor too strongly impressed upon the adult. We must all make some sacrifice, encounter some privation, to secure affluence or sufficiency in future. Savings' banks, benefit societies, clothing clubs, and all associations for collecting contributions to be afterwards applied for the benefit of the contributor, are founded upon this principle, and ought to be encouraged by landlords and employers, who should point out and explain their advantages, as well as take part in their management. It would be easy to adduce examples of the advantage arising from such institutions, but I will only cite one—the instance of a parish in Leicestershire, having a population of 700 persons. There are two clothing clubs established in this parish, one for the school children, and another for adults. The landlord, the rector, and principal occupiers, contribute liberally towards the support of the clubs, but about one-half the amount of the funds is subscribed in small sums, weekly or monthly, by the people themselves; and the result is, that there is scarcely a person who is not well clad, or a family without good bed-linen, in the whole parish. What has been done here, might be done in other parishes, if similar means were used for informing and

assisting the people, and leading them to the adoption of provident habits.

Where habits of self-denial and forethought are duly impressed upon the minds of youth in the process of education, and where these qualities are united with intelligence, sobriety, and industry in after life, they constitute the real wealth of the labouring classes, and will not fail to secure for them as large an amount of comfort as is compatible with their position. This truth it must at all times be a leading object to inculcate. If this were sufficiently attended to by teachers, and if superiors would add the weight of their influence to enforce it, fewer improvident marriages would be witnessed. Young men and young women would then look forward, and consider how they were to furnish their dwellings and support a family; and would delay entering upon the duties of married life, until by industry and economy they had acquired the means for coming together without violating the dictates of prudence, instead of acting in total disregard of all prudential considerations, as is now so frequently seen.

To be able to read and write is, in the present state of the world, almost as necessary as to be able to speak and think. The Scriptures are opened, and divine knowledge becomes accessible to every one who is able to read. The history of his country is then no longer a sealed book to him, and every Englishman ought to have some knowledge of his country's history, for how else can he fulfil the duties of a good citizen?—how else can he be expected to have the high national feelings essential for the maintenance of our national honour, which every British subject is bound at all hazards to uphold, and to be prepared at any moment to peril his life in defending?

To a knowledge of reading and writing, the common rules of arithmetic ought to be added; and here perhaps might end all that is at present necessary for the labourer in the way of education, for agriculture, as now conducted, affords little demand for the higher degrees of intelligence in the labourer. The skilled labour now required, is for the most part limited to mere manual skill in the common everyday operations of the farm—in ploughing, fencing, threshing, and so forth; but agriculture will not always be conducted as at present. Improvement has commenced, and must from its nature be progressive. More capital will be applied to the land, and science will become available to the farmer, who will then have a surer guide than mere empiricism. When this shall be the case, it is clear that a superior description of labourers will be required to carry out a superior description of operations. More skilled labour, more intelligence, will then be necessary; and a higher degree of education than what is actually required in the present day should

therefore be now imparted, in order to prepare the labourers for the higher degree of responsibility which will hereafter be devolved upon them. Moreover, the improved education of the labourer necessarily implies the improved education of the farmer. The employer cannot continue ignorant, when the workman is instructed. If we raise the lowest class, the class above it must at the same time be raised, or its position will be endangered; and that there is great room for improvement in the farmer class, will, it is presumed, not be denied.

It is in every case however, as before stated, above all things important that sound religious and moral instruction should be imparted in the process of education; and this is perhaps more especially necessary where the secular education is of an improved or higher description, in order to regulate the mind, and check the growth of self-conceit, and a tendency to be dissatisfied with their position, which superior knowledge is sometimes apt to impart to persons who feel or fancy themselves in a station of life below what their education has fitted them for. It has been said that "knowledge is power"—how important is it then, that with the power, right principles for directing it should be implanted! On our clergy more especially devolves the duty of instilling these principles, as accompaniments and correctives to the secular education of the working classes; and we cannot doubt that to their zeal and intelligence the duty may safely be confided.

But to teach the working classes the art of reading and writing is not sufficient. The means of using the knowledge thus acquired must be likewise placed within their reach, and this will best be done by establishing a small well-selected library in each parish or district of convenient extent, (say in connexion with the school,) the books to be lent out on certain conditions to persons in the neighbourhood; for the library need not be restricted to labourers only, but may be open to others, and would be especially useful to the smaller class of farmers, who often stand greatly in need of information, whilst in retired districts they are not unfrequently without the means of obtaining it. A small sum per volume might be paid for its use for a given time, and the contributions applied towards defraying the current expenses, and repairing or replacing the books when injured or worn out. The cost of establishing such a library might be borne by the neighbouring gentry, and others in easy circumstances, with whom would rest the duty of selecting the books, which ought to comprise works calculated to amuse as well as instruct, and suitable for the young as well as the aged.

Numerous examples might be adduced of the good effects of establishing schools, but it can hardly be necessary to cite them

here; for no one, it is believed, doubts the desirableness—indeed, it may be said, the necessity of education, or that it is a duty incumbent on the owners of property to provide all proper means for imparting it to the children of the working class. And with respect to lending libraries, these have been formed in so many instances by the exertions of landlords, clergymen, and other benevolent individuals, and always with such good results, that we feel warranted in saying no district, whether manufacturing or agricultural, should be without one.

In our efforts to secure a good education for the working classes, it must however be borne in mind that it is not by the head alone that the labourer is to live. The hands must likewise be taught, and accustomed to the skilful performance of their very important functions. Reading, writing, and arithmetic will not make a good ploughman. Training and practice are necessary for this, and for giving readiness and efficiency in agricultural operations. The training may begin at an early age, but it should be so conducted as not to impede the other objects of education. These observations apply equally to boys and to girls, the latter requiring the same degree of training for house and dairy work and other feminine occupations, that boys require for the field and the farm-yard; and the usefulness and success in life of each, will in great measure depend upon the manner in which the necessary instruction and training are imparted.

The farm and homestead will in general afford sufficient means for the industrial training of youths; but with girls the case is different, and other kind of assistance will be necessary to prepare them for fulfilling the duties of their station creditably and usefully. Many ladies take a lively interest in the education of the young females in their neighbourhood, and superintend the training and preparing them for service and other occupations. Nothing can be more praiseworthy than such conduct on the part of ladies of rank and affluence, towards individuals of their own sex peculiarly standing in need of all the aid that can be afforded, in order to ensure their usefulness and respectability in life.

I know of one instance, and I mention it as an incentive to others, where a lady has established a kind of training school for a number of girls, of the age of fourteen and upwards, selected from the schools in her neighbourhood. These girls are placed under a mistress, by whom they are taught to cut out and make their own garments, and to do the various kinds of household work. Some are trained for farmers' service, and some of the more apt the lady takes successively into her own house, where they are taught the duties of chambermaids, housemaids, kitchen-maids, laundresses, &c. When fitted for it, they are got out into

service; and there has rarely been an instance in which these girls have not turned out well.

If a good secular education were generally given, and sound religious principles and good moral habits properly impressed upon our rural population, and if all were duly trained to a skilful performance of their respective tasks, can we doubt that the position of the agricultural labourer would be improved, or that he would be a better member of society, better in his domestic relations, better to his employer, and better in himself, than he is at present?—To the realization of this result, to the securing of these benefits, the best efforts of the landed gentry of England, and of all others who take an interest in the welfare and happiness of their fellow-men, should be strenuously directed; and if they swerve not from the task, but follow it up earnestly, perseveringly, and with all singleness of purpose, they will assuredly reap a rich reward in witnessing the good which they have conferred upon others, no less than in the benefits which they will have secured for themselves.

3rd.—*To provide comfortable Cottages.*

The habitation of the labourer, taken with all its accompaniments, forms perhaps as important a consideration in connexion with his everyday comfort, as any other circumstance appertaining to his position in life. If the labourer be enabled to return from his daily toil to a cheerful home, and there see his family in comfort around him, it will conduce to health of body and contentment of mind. It is not a highly ornamented cottage which the labourer needs. Such structures may serve to display the builder's taste or the landlord's munificence, but they appear hardly in keeping with the labourer's position, and, it may be feared, are not unfrequently oppressive rather than a source of gratification, by the contrast which they present to his other domestic arrangements. What the labourer really requires is a habitation sufficiently roomy and substantial for the comfortable accommodation of his family, and furnished with appliances to answer his and their daily wants; and this assuredly ought to be provided for him, or he ought to possess the means of obtaining it.

Every cottage should have a sufficiency of light and ventilation, for which a glazed window, made to open, is necessary in each room. The health of the inmates will depend very much upon this being attended to, as it will likewise upon the proper drainage of the premises. The size of the cottage must of course be governed in some measure by the number of the family; but there ought always to be the means for a decent separation of the sexes

at night, and this can hardly be effected with less than four rooms. Yet how many instances are there in which families are crowded together in two rooms, or even in one room, outraging all decency! —in which youths and girls approaching to the state of young men and young women occupy the same sleeping-apartment, and that sometimes the same in which their parents repose! Is it possible that such improper interminglings can take place without demoralizing results? Can young females so brought up, be expected to have those feelings of modesty which constitute so great a charm, and form so important an element in the female character? Or can youths so reared in disregard of the decencies of life, be expected to turn out sober, discreet, and well-conducted; or to make good husbands, good fathers, and respectable members of society?*

In reference to these considerations, it may be assumed that no cottage should have less than four rooms—say two below and two above—with windows and suitable means of ventilation; that the ground-floor should be raised a foot or eighteen inches above the level of the surrounding surface, which must be properly drained; and that one of the upper chambers should have a fireplace, for use in case of sickness. A porch will add greatly to the comfort of the dwelling. The floors may be formed of brick, tile, or stone, unless the neighbourhood affords the means of making good clay or mortar floors, which sometimes answer as well. It is not important of what material the cottage is built, so long as it is roomy and substantial. Its form is moreover a matter of secondary importance, provided that convenience be attended to in its construction: but no cottage need be unsightly, although the merely ornamental is disregarded; for harmony of form and simplicity of arrangement never fail to produce a pleasing effect, without the aid of decoration.

The number of cottages required in any case must of course depend upon local circumstances, and to this point the landlord's attention ought to be especially directed. His position as owner of the land, necessarily imposes upon him the duty of providing for its proper cultivation; and cottages for the farm-labourers are as necessary for this object, as the house and outbuildings are necessary for the farmer, and the landlord should provide whatever is needful in the one case as well as in the other.

With respect to situation, it is obvious that the labourer's cottage should be near to his work, and that he ought not to be compelled to walk four, five, or six miles to his daily toil, thus

* Ample illustrations on this point will be found in the Local Reports on the Sanitary Condition of the Labouring Population, presented to Parliament in July, 1842; a few extracts from which are appended in a note (B) at the end.

imposing additional labour upon him without any countervailing benefit to his employer—indeed, to the employer's actual injury, for the exertion of going and returning must necessarily lessen the labourer's capacity for other exertion, and the employer will have by so much less work done. The labourers required for cultivating a farm, ought therefore to be provided with habitations conveniently situated within its limits, or immediately adjoining. This would unquestionably be for the farmer's interest, and if the farmer's, it must likewise be the landlord's, for the interest of each requires that the land should be so cultivated as to yield the largest amount of produce at the least amount of cost.

In many instances it may be necessary that the cottages should be situated on the farm on which the labourers are employed, and this is more especially necessary where the farm is large, in which case they would of course be provided by the owner of the land. In other instances, a neighbouring village may possibly afford the best means of accommodating the labourer; but in this latter case, neither the landlord nor the farmer ought to consider himself exonerated from the duty of attending to the state of the dwellings. They should see that the labourers are provided with suitable habitations, and moreover that they obtain them at suitable rents. Exorbitant rents are often exacted for miserable dwellings, in which the requirements of comfort and decency are alike disregarded, and in which if health be preserved it amounts almost to a miracle. Such cottages are for the most part the property of some village speculator, or they belong to the village shopkeeper, who stipulates for supplying the inmates, and on whom the labourer thus becomes in a double sense dependent.

From these and similar hardships and impositions it is the duty of employers to protect their people, which can only be effectually done by providing suitable cottages for them to reside in, at reasonable rents. That it is the interest of the employer to do this is clear, for if the labourer be compelled to pay an exorbitant rent for his dwelling, or an exorbitant price for the articles which he consumes, he must be paid higher wages. If this be not done, the labourer will sink below the level in point of comfort which it is necessary that he should maintain in order to ensure the full development of his physical powers, in which case he will not only be less efficient, but he can then hardly be expected to feel contented in his position.

Many of our landlords, influenced by these and similar considerations, have incurred much expense in repairing and enlarging the cottages on their estates, and providing suitable dwellings for their labourers; and they have been rewarded by seeing a

contented peasantry around them, and by feeling that in attending to the comfort and well-being of their people, they have taken the most effectual means for promoting their own.

In certain counties the labourers, instead of being provided with cottages conveniently situated with respect to the farm on which they work, are congregated in villages of considerable size. This is owing to the demolition of cottages, and the practice of clearing parishes and estates, which has been adopted of late years, with a view to lessen the amount of the poor's rate. Where this has been done, the labourers, instead of living under and being employed directly by the farmer, become the servants of a gangsman or undertaker, who bargains with the farmer for the work to be executed, and then hires a gang of people to do it. He of course makes the best bargain he can with the farmer, and pays as little as he can to the people, who are thus excluded from all intercourse with their natural superiors, and placed entirely at the mercy of a hard and grasping schemer.

Out of these circumstances has, moreover, in a great measure arisen the now prevalent practice of employing females in the rougher descriptions of field-labour. The gangsman, having undertaken for the performance of certain work, hires the cheapest labour that can be obtained; and as women work for less wages than men, he engages as many of them as possible, and in such cases it is not uncommon to see more women and girls at work in a field than there are men. It may be that field-labour is not generally injurious to the health of females, although there is much conflicting evidence upon this point; but no one can doubt its injurious effects upon their manners and morals, or that it is unfeminine, and tends to put them out of their proper position in society. The Reports of the Commissioners appointed in 1842 to inquire into employment of women and children in the agricultural districts, present important evidence on these points, and to them the reader is referred for further information on the subject.

But whether the employment of females in common field-labour be open to much or to little objection, there are unquestionably other employments better suited to their sex and circumstances. Independently of household work, and matters strictly appertaining to the female department of cottage economy; and of garden-work, and the lighter descriptions of agricultural labour at certain seasons, which are not open to the objections that attach to habitual field-labour at all seasons, as now practised in the instances above adverted to—independently of these, the females in the rural districts might find abundance of suitable employment in the management of the flax-crop in its different stages, if the growth of flax were more attended to in this

country; and this consideration, irrespective of the profit which would accrue from it if properly conducted, affords a strong reason for extending its cultivation.*

4th.—*To provide Cottage-Gardens.*

It is not here proposed to discuss the question of allotments, or what is called the allotment system, about which there are conflicting opinions, some contending for its advantages, whilst others denounce it as injurious, and as being calculated to change the position of the English labourer working for wages, into that of the Irish cottier subsisting on his modicum of land. Into this controversy I will not enter, but will merely remark, that whatever serves to divert the labourer from a reliance upon his daily wages as a means of support, must tend to derange the natural relations between him and his employer, and will eventually prove injurious to both. The following observations will therefore be strictly confined to the subject of cottage-gardens, which are not open to this objection, and with respect to which there can scarcely be any difference of opinion; for that the cottager ought to have a garden of some sort attached to his dwelling, has, it is believed, never been denied.

In a work published last year, expressly for the use of the agricultural classes, it is stated that "the possession of a quarter of an acre of garden-ground may, and often will, make to the labourer and to his family the difference between want and sufficiency, between privation and comfort, between a contented mind and the cheerful fulfilment of the duties of his station, and a mind soured, hardened, and dissatisfied, prepared to yield to vicious promptings, and to rush recklessly into breaches of the law."†

If, then, the attaching a garden to the labourer's dwelling is, and is generally deemed, so desirable, why, it may be asked, has this not been more generally done? The only answer we can give is, that the omission may possibly be owing to the difficulty of so fixing the attention and working upon the convictions of the landowners and employers of labour, as to arouse them to exertion with sufficient earnestness for overcoming local impediments; and thus it is, that this general admission of the expediency of providing cottage-gardens has failed of leading to the accomplishment of an object allowed on all hands to be so desirable, so necessary.

Where the owner of the surrounding land is likewise owner of the cottage, local impediments can be readily overcome by the

* See a work recently published, entitled 'On the Cultivation of Flax, the Fattening of Cattle with Native Produce, Box Feeding, and Summer Grazing,' by John Warnes, Esq., of Trimingham, Norfolk.

† 'The Farmer,' published by Charles Knight, 1844.

will of the landlord, who may attach to the cottage a plot of adjoining land, or land so nearly adjoining and ready of access, as to impose no material inconvenience upon the labourer and his family in its cultivation. But where the ownership is in other hands, less will be directly in the power of the landowner, who may then have to exert his influence for obtaining a plot of ground for the purpose.* There can be no doubt, however, that if the chief landowners and leaders of the agricultural interest throughout the country, would earnestly set about providing suitable cottages and cottage-gardens for the labourers on their estates, it might soon be accomplished, and the dwellings would speedily assume a more cheering aspect, and the labourers' families would have a more happy and contented appearance than is now often witnessed.

That it is expedient, if it be not absolutely necessary, that some effort for accomplishing this object should be promptly made, every one who attends to the temper and circumstances of the times will admit. The working classes have of late years become of far greater weight and importance in the community than heretofore. Their increase in influence has fully kept pace with their increase in number; and the importance of cementing the different orders of society into one harmonious whole, and restoring or creating a closer sympathy and connexion between the higher and the lower grades, is every day becoming more obvious and more urgent. The first step in this direction must be, to endeavour to make the working classes more happy and contented, by improving their condition and increasing their comforts. The people must be made to see and to feel that they have something to lose, that their position has its advantages as well as its privations; and that although theirs is of necessity a life of labour and endurance, from which the more fortunate portion of the community are in a great measure exempt, they are yet cared for and appreciated by their superiors in station. This would impart a new and improved tone of feeling throughout our rural population, and there is perhaps nothing that would be more conducive to this end than attaching a garden to every cottage.†

* "Charity lands contiguous to villages, or to clusters of cottages, have in many instances been subdivided into allotments for the poor, with great success; and thus the benevolent object of the original donor has been carried out in a twofold capacity. It seems obvious indeed that as these estates frequently consist of insulated fields, no better application of them can be adopted; added to which, the tenure under trustees is more certain, nor are the poor occupiers subject to be disturbed by a capricious landlord, or liable to having their rents raised from mercenary motives."—Braybrooke.

† See a short but valuable article by Sir H. E. Bunbury, page 391, in the Society's Journal of last year.

We can hardly over-estimate the importance of a garden to a labourer's family. It not only adds to their physical enjoyments, by enabling them to have many little comforts which they would otherwise not possess, but it likewise operates beneficially in a moral sense, by daily presenting to the eye objects interesting alike to parents and to children—objects on which they have planned and thought and worked together, which they can call their own, and in which they can therefore each and all feel a pleasure and a pride. The labourer will look forward to returning after his daily toil, and joining his family in ornamenting and improving his garden, in calculating upon its future crops, or rejoicing in its present produce. His cottage and his garden will be associated in the labourer's mind with his wife and his children, the whole constituting a little world within which his dearest affections are centred.

Without a garden, the cottage with its confined limits must always be inconvenient, and comparatively cramped and void of comfort. There is no out-of-door object for the labourer and his children to occupy themselves upon in common. They would be driven into the streets or lanes, and he, too probably, would seek refuge in the alehouse. But if a garden be attached, the cottage will then appear, and in fact almost become, more roomy, as it certainly will be more cheerful. The children may be turned into the garden, where they will find occupation and amusement, and at the same time gain health and strength. There too they will learn a taste for flowers, and in teaching the young people to plant and train and cultivate them, the parents will derive pleasure whilst imparting instruction; and the knowledge and the habits thus acquired will remain with the children in after-life, and exercise an ameliorating influence upon their character and pursuits.

The size and situation of the garden must of course depend very much upon local circumstances. It ought not, however, in any case to be so large as to interfere with the labourer's regular occupation, or withdraw him from his every-day pursuits; and from a quarter to half an acre, according to circumstances, would, I think, generally be sufficient. Wherever practicable, the garden should certainly adjoin the cottage, to which it might be rendered ornamental by planting shrubs and flowers, thus imparting a cheerful appearance to the labourer's home, and giving it attractions and occupations for his intervals of leisure, which would be a means of keeping him from idle associates, and from falling into dissipated or vicious habits.

If it be found impracticable to have the garden immediately adjoining the cottage, in such case it ought to be as near to it as

possible; for if distant, the time spent in going and returning will detract greatly from its value. The wife and children will not then have the same ready access to it, nor the same pleasure in it. It will not be as it were a part of their dwelling, nor form the same object of common interest and common care to the whole family. It will not become associated in their minds with the idea of *home*, nor exercise the same beneficial influence upon the feelings and affections, as if it immediately adjoined and formed a part of the labourer's dwelling. A distant garden is however better than no garden at all, and if it cannot be obtained near to or immediately adjoining the cottage, let it by all means be provided at a distance, until a more eligible plot can be obtained.

With a garden of a quarter of an acre, the labourer can keep a pig, which the refuse vegetables from his garden will enable him to rear, and nearly support. He may also keep bees, the value of which is well known to the thrifty housewife. These will serve as helps, and enable his family to enjoy many little comforts which otherwise they would be unable to obtain; and if, in addition to his garden, the labourer were to be allowed a bit of land in the corner of a field to raise his potatoes, and a little milk for his children from the farmer's dairy, it would be of the greatest use to him, without being missed by his employer.

It can scarcely be necessary to refer to examples in support of the foregoing recommendation as to cottage-gardens. The extreme desirableness, not to say necessity for such a provision, must be sufficiently obvious: but if an example be desired, I am enabled to refer to an extensive property in Shropshire, where every labourer on the estate has a comfortable dwelling, generally of four rooms, and with a garden either attached to the cottage or at no great distance from it; and there cannot be a more contented and orderly peasantry, or people more attached to their landlord than will there be witnessed—a natural consequence of the landlord's attention in promoting their comfort and welfare.

Conclusion.

None of these recommendations have been offered with the view of interfering with wages, which would be opposed to sound principle; but the suggestions are proposed simply as means for ameliorating the labourer's condition, improving his habits, and adding to his comforts, thereby rendering him more contented in his position, more competent to fulfil its duties, a better man and a better citizen.

It may perhaps be said that the labourer's condition will depend upon the amount of his earnings, which in the long run will be

governed by competition in the labour-market. This is true in the main; but the manner in which the labourer lives, the amount of comfort which he is enabled to command, must likewise be taken into account; for as the well-being of the community requires that the labouring classes should enjoy the largest amount of comfort compatible with their position, everything which can be done in furtherance of this object ought to be adopted, taking care not to derange the great principle of competition in regulating the price of wages. All our efforts for improving the condition of the working classes must be in subordination to this ruling principle, with the view of mitigating its intensity in particular instances, not of counteracting its general working.

In all competitions, there must of course be competing parties. In competition for wages, there are the employers and the employed; those who wish to get labour for wages, and those who wish to get wages for labour. While the amount of wages offered on the one hand, and of labour offered on the other, remain stationary, wages will remain stationary. This, however, is not the case in this country, the fund for the payment of wages and the supply of labour being both, as has been shown, rapidly increasing every year. If both increased at the same rate, wages would not be affected. If the fund for the payment of wages increases more rapidly than the supply of labour, wages will rise; if less rapidly, they will fall. This is briefly the theory of wages; and most of the suggestions I have offered for improving the condition of the labouring classes aim at increasing the wages-fund, the amount of which will depend on the diligence and skill of the labourer, and the enterprise and good management of the employer. If the labourers are idle or unskilful, their labour will be less productive. If the farmer be incompetent, wasteful, or timid, he will not employ the necessary amount of labour, or he will employ it unskilfully; and in either case the fund for the payment of wages will be less than it ought to be, or than it would be under better management.

Whenever the wages-fund does not increase, or if it increases slowly, whilst the number of those to be supported by it increases rapidly, it is evident that the labourers must suffer, and especially the least skilful, who will first be driven to compete for employment by accepting lower wages; but eventually the more skilful labourers will be driven to compete in like manner, and this competition will tend to lower the condition, to lessen the comforts of the whole labouring population. Competition is, however, limited in its action upon wages, by the amount necessary for the labourer's subsistence, taking the term in its largest sense; for below this amount it is obvious that the general range of wages cannot long be depressed. Competition of labour for wages may,

moreover, be affected by restrictive laws, by exclusive privileges, or by the habits and customs of a people.

The general tendency of circumstances in this country is to reduce the earnings of the agricultural labourer, who is virtually confined to his parish by our law of settlement, whilst the number of employers is limited by the number of farms. There is, moreover, for the most part, an indisposition among farmers to apply the requisite amount of capital to the cultivation of the land —often, perhaps, an inability to do so; and thus the field of labour remains stationary, or becomes restricted, whilst our labouring population goes on increasing from year to year Under such circumstances, competition on the part of the labourers must be far greater than it is on the part of the employers; and if it were carried to its full extent, without intervention of any kind, it would by its continued pressure reduce the labourer to the lowest level of subsistence, leaving him the smallest possible amount of the comforts and enjoyments of life, if indeed it left him anything beyond the mere necessaries.

Against this tendency to depression in the social scale, the labourer has to struggle; but the contest is somewhat unequal, for his necessities press him close, his daily living depending upon his daily labour; and the result would perhaps be more decidedly adverse to him than it is, were it not for certain correctives incident to our social position. One of the most influential of these is the impulse arising out of the better feelings of our nature, and strengthened alike by reason and religion, to endeavour to benefit our brethren of every class, and especially those standing most in need of our aid. On the extent to which this impulse is called into operation by the habits and institutions of a country, will the condition of its people in a great measure depend; and in England our free institutions happily provide the fullest incentives for its development in the most effective form.

Another corrective to the tendency of competition to depress the labouring class, will be found in the generally recognised necessity of preventing any considerable section of the community from sinking so low as to render them reckless and prone to disorder, thereby endangering the security of property and the ascendancy of law. If a man have nothing to lose by disorder, he cannot be expected to be a strenuous supporter of order. If he has no property of his own, we can hardly expect to find him arrayed on the side of property. To be interested in the preservation of the property of others, a man must have something of his own to be preserved; and hence, whilst competition is operating to depress the labourer, it becomes the interest of those above him to step in and sustain him in a certain position, below which if he were permitted to sink, property would become insecure, and the well-being of society would be endangered.

These two circumstances operate as a counterpoise to competition as respects the labourer, and on these are mainly grounded the suggestions herein offered for improving his condition. In a modified shape, they are acted upon by every landlord in dealing with his tenantry; for although the price of land, like other prices, is governed essentially by competition, the judicious landlord will never exact from his tenant the utmost amount of rent which unlimited competition would give him, nor such a rent as would reduce the capital or lower the condition of his tenant, well knowing that his so doing would lead to his own eventual loss. He therefore has a regard for his tenant's interest as well as for his own, it being necessary that the tenant's position should be maintained, in order to secure the best return from the land. In like manner the comfortable position of the labouring class must be maintained, for the security of property and the general well-being of the community; and in both cases the duty of maintenance devolves mainly upon the landlord, as a condition annexed to the possession of property.

The ownership of land imparts very important privileges, but it likewise imposes very important duties, not one of the least of which is that of providing for the comfort and welfare of those by whose labour the land is rendered productive. If it be objected that the labourer is now a free agent, bound to provide for his own wants by his own exertions—that he is no longer a serf or slave looking to his master for protection and support, but stands upon an equality with his employer in all civil rights, giving his labour in exchange for wages with as much freedom as the employer gives wages in exchange for labour—if this be objected, we must admit the fact; but it does not follow that the relations between the parties have necessarily become antagonistic, for there is still much to bind them together in the bonds of a common interest, much to make the welfare of the one dependent on, if not actually identified with, the welfare of the other. The labourer must have employment, in order to obtain the means of living. The employer must have the best description of labour, in order to obtain the best return on his capital. To secure the best description of labour, the labourer must be trained and taught, his intellectual as well as his physical qualities must be cultivated, and he must be sustained in the position best calculated for their development. This is necessary for the interest of the employer, without reference to that of the labourer. But, irrespective of these considerations, there is, as above stated, a duty imposed on the possessor of property, involving the very condition on which its secure enjoyment and free transmission are guaranteed, and that is, to watch over and promote the general well-being of those subordinate to or in any way dependent upon him.

Instances have been referred to in which each of the foregoing

suggestions has been acted upon; and were it not that I have felt precluded from mentioning names, specific examples might have been cited, showing results more or less beneficial, according to the judgment with which they were introduced and the steadiness with which they were carried out; but still invariably beneficial. All such instances, however, have been isolated and local, depending on the influence of some particular landowner, or the efforts of some benevolent individual; and to cite them in detail would add little in support of the suggestions, which are moreover to be taken collectively; for unless so taken and acted upon systematically as a whole, the full amount of the benefits they are calculated to produce cannot be expected to arise from their adoption.

No one will deny that increased employment, improved means of education, comfortable cottages, and convenient cottage-gardens, are each good, and that to establish either where it does not now exist would be productive of benefit: but to secure the largest amount of benefit derivable from them, not only in the aggregate but from each singly, they must *all* be introduced as essential parts of the same system, and be acted upon at the same time. Of this systematic and simultaneous action it is believed no complete example can be found, and the suggestions for its adoption which have here been offered must therefore rest in great measure upon their own merits without the support of example, which, however authoritative with respect to operations on mere matter where the effects are uniform, is of less weight as regards objects immediately connected with the feelings and habits of a people, which come under a different category and must be judged on a different principle.

It is only further necessary to add, that the foregoing recommendations are offered to the opulent of every class, and more especially to landowners and the employers of labour, under a conviction that they will be found safe, suitable, and generally sufficient for the end proposed; and that if they fall short of remedying every evil to which the agricultural labourer is now subject, they will at least go far towards it, without violating principle, or causing danger or derangement of any kind. The writer's conviction in this respect is founded upon thirty years' pretty close attention to the habits and condition of the labouring classes, and that under circumstances often peculiarly favourable for enabling him to arrive at correct conclusions on this most interesting and important question.

George Nicholls.

London, February 1st, 1846.

Note A, referred to at page 7.

In proof of what can be done in the way of improvement, by a right understanding between the landlord and tenant, an instance may be cited of a farmer possessing skill and capital, who took a large farm in Wiltshire, on terms which at once encouraged and enabled him to improve the property. On entering upon the farm, he brought with him his ploughman, and two or three of his best labourers; but the other farmers in the parish became alarmed at this, and complained that he was bringing a burthen upon them, there being already, as they declared, more labourers than could be employed. The next winter these farmers, as usual, turned off several of their men, whom the new-comer immediately engaged, as he wanted them for draining, fencing, and the other works necessary for good and successful farming, but which had hitherto been altogether neglected. On the return of spring the men were, of course, again wanted by their old masters, but the new-comer had engaged them all *permanently;* and thus the persons who had been complaining of over-population, and the introduction of non-parishioners, were themselves compelled to seek for labourers out of the parish, the field of employment having been so far enlarged as to afford full occupation to every labourer belonging to it.

Note B, referred to at page 17.

Extracts from a Letter of the Clerk of the Ampthill Union. January 23rd, 1841.

"I think I may affirm it to be an established fact, that the occupiers of comfortable and convenient cottages are generally in all respects superior to those of tenements of an opposite description, which is displayed in their being better clothed, their more orderly deportment, their more regular attendance at a place of worship, their greater anxiety to maintain a good name, the more respectable and comfortable appearance of their families, &c. From them also there are proportionably fewer applications for parish relief, I should say especially on account of sickness. It is generally seen that labourers whose homes are clean, comfortable and convenient, do not frequent the beer-shop so much as those whose homes are wretched, filthy, and miserable, and cannot by exertion be much improved. It may reasonably be expected that a man after his day's work should resort for those comforts which his home does not afford somewhere else; that place in most cases will be the beer-shop, and the result is an increase of wickedness and depravity. From these facts I feel fully persuaded that, were it practicable, a general improved cottage accommodation would certainly tend to produce amongst the labouring classes a generally corresponding moral improvement.

"A large proportion of the cottages in the Union are very miserable places, small and inconvenient, in which it is impossible to keep up even the common decencies of life. I will refer to one instance with

which I am well acquainted. A man, his wife and family, consisting in all of eleven individuals, resided in a cottage containing only two rooms. The man, his wife, and four children, sometimes five, slept in one of the rooms, and in one bed, some at the foot, others at the top; one a girl above fourteen, another a boy above twelve, the rest younger. The other part of the family slept in one bed in the keeping-room, that is, the room in which their cooking, washing, and eating were performed. How could it be otherwise, with this family, than that they should be sunk into a most deplorable state of degradation and depravity? This, it may be said, is an extreme case; but there are many similar, and a very great number that make near approaches to it. To pursue a further account of this family:—The man is reported to be a good labourer; the cottage he held was recently pulled down, and, being unable to procure another, he was forced to come into the workhouse. After being in a short time, they left to try again to get a home, but again failed. The man then absconded, and the family returned to the workhouse. The eldest, a female, has had a bastard child; and another, younger, also a female, but grown up, has recently been sentenced to transportation for stealing in a dwelling-house. The family, when they came in, were observed to be of grossly filthy habits, and of disgusting behaviour; I am glad to say, however, that their general conduct and appearance is very much improved since they have become inmates of the workhouse. I without scruple express my opinion that their degraded moral state is mainly attributable to the wretched way in which they have lived and herded together as previously described."

Extracts from a Letter of the Chairman of the Bedford Union. January 4th, 1841.

"I consider that the improvement has arisen a good deal from the parties feeling that they are somewhat raised in the scale of society. The man sees his wife and family more comfortable than formerly: he has a better cottage and garden; he is stimulated to industry, and, as he rises in respectability of station, he *becomes aware* that he has a character to lose. Thus an important point is gained. Having acquired certain advantages, he is anxious to retain and improve them: he strives more to preserve his independence, and becomes a member of benefit, medical, and clothing societies, and frequently, besides this, lays up a certain sum quarterly or half-yearly in the savings' bank. Almost always attendant upon these advantages we find the man sending his children to be regularly instructed in a Sunday-school, and, where possible, in a day-school, and himself and family more constant in their attendance at some place of worship on the Lord's-day.

"A man who comes home to a poor comfortless hovel after his day's labour, and sees all miserable around him, has his spirits more often depressed than excited by it. He feels that, do his best, he shall be miserable still, and is too apt to fly for a temporary refuge to the alehouse or beer-shop. But give him the means of making himself comfortable by his own industry, and I am convinced by experience that, in many cases, he will avail himself of it."

Extracts from a Letter of the Clerk of the Stafford Union. January 20th, 1841.

"If we follow the agricultural labourer into his miserable dwelling, we shall find it consisting of two rooms only; the day-room, in addition to the family, contains the cooking utensils, the washing apparatus, agricultural implements, and dirty clothes; the windows broken and stuffed full of rags. In the sleeping apartment the parents and their children, boys and girls, are indiscriminately mixed, and frequently a lodger sleeping in the same and the only room; generally no window, the openings in the half-thatched roof admit light and expose the family to every vicissitude of the weather—the liability of the children so situated to contagious maladies frequently plunges the family into the greatest misery. The husband, enjoying but little comfort under his own roof, resorts to the beer-shop, neglects the cultivation of his garden, and impoverishes his family. The children are brought up without any regard to decency of behaviour, to habits of foresight, or self-restraint: they make indifferent servants, the girls become the mothers of bastards, and return home a burden to their parents or to the parish, and fill the workhouse. The boys spend the Christmas week's holiday and their year's wages in the beer-shop, and enter upon their new situation in rags—associating with the worst of characters, they become the worst of labourers, resort to poaching, commit petty thefts, and add to the county rates by commitments and prosecutions.

"On the contrary, on entering an improved cottage, consisting on the ground-floor of a room for the family, a wash-house, and a pantry, and three sleeping-rooms over, with a neat and well-cultivated garden, in which the leisure hours of the husband being both pleasantly and profitably employed, he has no desire to frequent the beer-shop or spend his evenings from home; the children are trained to labour, to habits and feelings of independence, and taught to connect happiness with industry, and to shrink from idleness and immorality: the girls make good servants, obtain the confidence of their employer, and get promoted to the best situations. The boys, at the termination of the year's engagement, spend the Christmas week's holiday comfortably under the roof of their parents; clothes suitable for the next year's service are provided, and the residue of the wages deposited in the savings' bank."

II.—*On White Mustard.* By Thomas Cooke Burroughes.

Prize Essay.

The cultivation of white mustard as a fallow crop, either for sheep-feed or to be ploughed in as a green manure, may be said to be a new system in British agriculture: for although it has been long since used with success by some few experimental farmers, yet the practice of it has never been so general as in the last two years, and especially in the summer of 1845, when numerous patches and some large pieces of white mustard might be seen growing in almost every parish where the soil was adapted to its cultivation.

The *sound* only of "*mustard*" has, I believe, deterred many farmers from growing it, as some persons are apt to confound the white mustard with the black mustard (or brown mustard, as it is called in some parts). The former plant—the subject of this essay—is that which is grown in our gardens to use as a salad, and is the "Sinapis Alba;" and the latter is the "Sinapis Nigra" of Linnæus.

The black mustard is a more exhausting plant to the soil than white mustard, and may well be shunned by all good farmers who wish to keep their land clean; as the seed of this plant, if allowed to come to maturity and shelled upon the ground, will come up in after years to the great detriment of the succeeding corn-crops; for, like the charlock seed, it will remain in the soil for ages uninjured, and, when brought near the surface by cultivation, will vegetate in abundance.

White mustard is a far more harmless plant, and, if allowed even to shed its seed, vegetates so quickly and with the slightest moisture, even upon the surface of the soil, and is so easily destroyed by frosts, that even when grown as a seed-crop but few of its species are found in the succeeding crop, if a winter intervene.

Having described the nature of the two sorts of mustard, I now proceed to the following points required in this Essay upon white mustard.

No. 1.—*Quality of Land on which sown.*

I consider there is scarcely a soil, however poor (provided the climate be adapted to it), upon which white mustard will not grow; but, of course, like all other plants, its luxuriance of growth will be according to the fertility of the soil, provided it be rendered in a fit state to receive the seed. A good friable turnip-soil, capable of producing good crops of wheat, with a dry subsoil, is well adapted to its growth; and also peat-soils, upon which it flourishes with extreme luxuriance.

No. 2.—*Mode and Time of Sowing, and Quantity of Seed.*

As the more the plants are dispersed over the land the better will the weeds be smothered, the most approved method is to sow it either by a seed-drill having no coulters or by a barrow seed-engine (first made by Bennet, of Farnham, Kent, but now common all over England); or in case of neither being ready, a well practised and careful seedsman may sow it evenly enough by hand to answer all purposes.

The land should be rendered as fine a tilth as if required for turnips, by one or more ploughings, &c., if necessary, and the seed be sown upon a harrowed surface and then covered by light seed-harrows, going twice over the ground, the second time across or obliquely.

A peck per acre is the usual quantity of seed; but three-fourths of a peck of good sound seed, if the land be in a very fine state, may be found sufficient.

Should the ground be in a very dry or cloddy state, it would be advisable to delay sowing the seed until a gentle rain shall have fallen; but by no means *puddle it in* when the land is in an extremely wet state, as dry weather quickly following would be apt to cause a crust upon the top of the soil, which would much hinder its progress in coming up.

No. 3.—*Period of Maturity, according to the Season of the Year.*

If the seed be sown in May or June, or up to the middle of July, the crop will in an average of seasons have attained to its full growth, *i. e.*, be ready to burst into bloom in six or seven weeks. But after that season of the year its progress in growth is slower, as the autumn advances; and when sown in August, it will usually be eight to ten weeks in coming to maturity, but much depending upon the warmth and moisture of the season. It may in a favourable autumn be sown even as late as the end of September, and produce a considerable bulk of crop, to be ploughed in before the winter frosts destroy it.

In referring to my journal kept during the summer of 1845, I find I ploughed up 6 acres of fallow on a light turnip-soil, which had been sown with rye-grass (in the wheat-crop the previous year) and fed off and folded by sheep, which was rolled down and harrowed, and sown with a peck per acre of white mustard—4 acres on the 10th. and the remaining 2 acres on the 16th of May; and on the 21st of June I began to feed it off (being about 2½ feet high) with 228 sheep and 70 lambs; which kept them, being folded upon it at night, with only an old bare layer to exercise upon in the day, twelve days; and upon which the sheep much improved in condition.

On July 8th and 11th, the whole was sown with white turnips, after one ploughing and deep scarifying. The turnips came up rather shy, and grew slowly at first, and were not quite a full plant, but very good size in bulb. I also sowed four acres of white mustard *after tares*—2 acres on the 5th, and 2 acres on the 11th of August, 1845; after one ploughing and sundry harrowings, and upon a fertile mixed soil, and which I began to feed off with sheep on the 10th of October; it being then a very fine crop, nearly as high as the hurdles. It is now sown with wheat.

No. 4.—*Application of Crop, whether as a green Manure or to be fed off by Sheep.*

As a *green manure*, I regret that the time restricted to sending in this Essay will not give me an opportunity to witness the effects of its being ploughed in; although the forthcoming harvest will afford me ample and numerous instances of its effects upon barley and wheat crops, the latter upon my own farm, the result of which I shall be happy to communicate to the Society, should it be desired. I can only say that my present growing crop of wheat, after mustard ploughed in, which was sown after tares, presents a healthy and luxuriant appearance; and where wheat was sown after mustard, folded off by sheep, in October last (as before mentioned), the fulness of plant and healthy appearance far exceed, at present, wheat put in rather earlier upon a clover-layer and sheep-folded.

For *sheep*, mustard is a healthy food; but, of course, like all other succulent vegetables, should be given sparingly at first, and if in conjunction with some other food during the first few days, all the better: but I never heard of a sheep dying from eating it, its pungent quality probably assisting digestion. It is in its greatest perfection for eating just before it comes into blossom, but as its progress towards flowering is so rapid, it is advisable to begin stocking it several days or a week before it is in this state, otherwise it will become too old and sticky. It is also better sown in successions, about twice a-week, according to the number of sheep it is required for. Although bulky in appearance, there is not above half the *wear* in it that there is in a good crop of cole; but it may be sown to come into use at a time when flock-masters are put to much inconvenience to provide for their sheep: and if sown upon a clean fallow in the latter part of April or beginning of May, a fair crop of white turnips *may* succeed it; but where a bulky crop of turnips is of indispensable importance, I cannot recommend, from the experience of both myself and others, its culture as an intermediate green crop.

Upon turnip-soils, where a portion of the fallows are obliged to be sown with tares for the support of the teams or the flock,

white mustard following these, either to be fed off by sheep, or ploughed in as a green manure, may answer the purpose of either very well. It is said also to be an antidote to wireworm.

It is, moreover, a very useful crop to grow upon a heavy land fallow (unfit for turnips), sown about midsummer, after the land has received its due culture, and eaten off by sheep in August or September, previous to laying up the land for winter.

In ploughing the crop in for a green manure, it should be taken before exhausting the land by flowering; and it is highly desirable that all the top ends of the plant be well turned under the furrow, which can only be accomplished by means of a chain, one end being fastened to the "hake" of the plough and the other to the top of the coulter; a wooden clog being in the centre of the chain to keep it down, and dragged along the bottom of the furrow, by the motion of the plough, just before the succeeding furrow falls upon it. In this way I have seen mustard as high as the horses' noses are off the ground effectually turned in.

Gazeley, near Newmarket,
February 28th, 1846.

Note on White Mustard.

Mustard is certainly not in general a dangerous food for sheep; but as one instance of serious injury has occurred from its use in my own neighbourhood, it is right that the circumstances of that injury should be known, in order to prevent the recurrence of a similar loss. They are stated as follows, in a letter from Mr. Williams, of Buckland:—(Ph. Pusey.)

"I am sorry to say I have had a loss with my sheep from eating mustard; but I consider it purely accidental. My son had sown about 3 acres: in six weeks it was fit for the sheep; we did not begin it, however, until the end of about 9 weeks. For the first 4 days the sheep ate it well; and wishing to consume it as quick as we could, to plough the land for wheat, my shepherd, seeing the sheep do well, ventured to give them a double quantity: the consequence was, the whole flock of 205 ewes were all of them in a most alarming state when found in the morning, 5 of which were dead, and most of the others much swollen; only the 5, however, died; and I consider it was entirely by giving them so much. We, after a few days, ventured the same sheep upon the rest; and finally, they finished it without any failure."

III.—*On the Farming of Cambridgeshire.* By Samuel Jonas.

Prize Report.

In attempting to write a Report on the Farming of the County of Cambridge I feel the difficulty of the task I have undertaken; and how truly it may be said that practical farmers are not qualified to convey to others their opinions and sentiments in the clear and concise manner so necessary to engage attention: for, although very extensively engaged as a tenant-farmer in the cultivation of land, I feel myself unable to write clearly on that business in which my whole time is occupied. I must trust, however, to the public to overlook the style, and attend to the practical information I may indite.

Cambridgeshire is a purely agricultural county, no manufactures being carried on in it; so that the whole of its population may fairly be said to be agricultural. This population (1841) was as follows:—Males, 81,611; females, 82,848. Total population, 164,459.

The county contains about 536,313 acres of land. Mr. Vancouver states, that in 1794, 112,500 acres were unimproved—fen, common, and sheep-walks; but Mr. Gooch writes, in 1806, that full 63,000 acres of this waste were then cultivated. Therefore, presuming that 63,000 acres have been broken up and cultivated for half a century, yielding an annual produce of 4*l.* per acre, we have an increase of wealth thus added to the state within the above period of fifty years, of 12,000,000*l.* from this land, or an annual increase of produce worth 252,000*l.* I am not able to point out the annual increase of produce on the old cultivated parts now, as compared with the annual produce in 1806, but it must be to an extent that would not easily be credited, in consequence of the whole county being enclosed, with the exception of four or five parishes, and having been rendered doubly productive by improved systems of cultivation. And as this county is purely and exclusively an agricultural one, I hope it will not be deemed irrelevant to this subject if I point out how the breaking up and converting this waste into productive land, by thorough-draining the clay district, draining and claying the fens, and the improved system on the light land district, has created such a demand for labour, as to have absorbed the amazing increase of our population since 1801, when the population was only 89,364; while in 1841 it had increased to the extent of 164,459, being an increase of 75,113 in the period of forty years. This increase has found employment in agricultural pursuits, or as tradesmen, mechanics, and artisans, in supplying the wants of those engaged in agriculture.

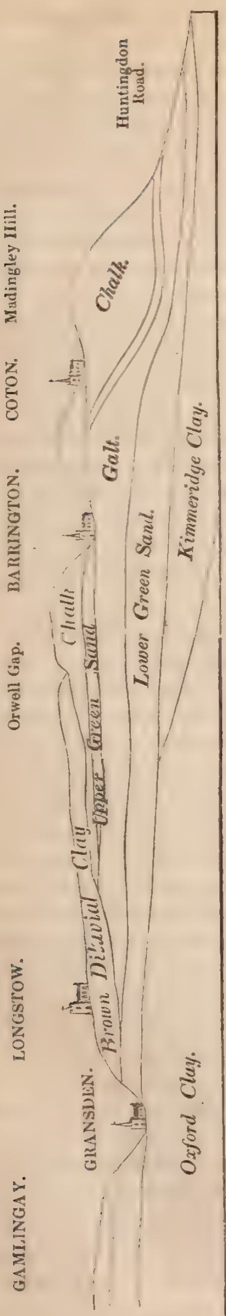
In 1806, by Mr. Gooch's Report, it appears that we had about 49,500 acres of uncultivated waste land, which are now reduced, according to the best information I can obtain, to about 10,000 acres; 5000 of which are summer lands, mown or fed, but subject to floods.

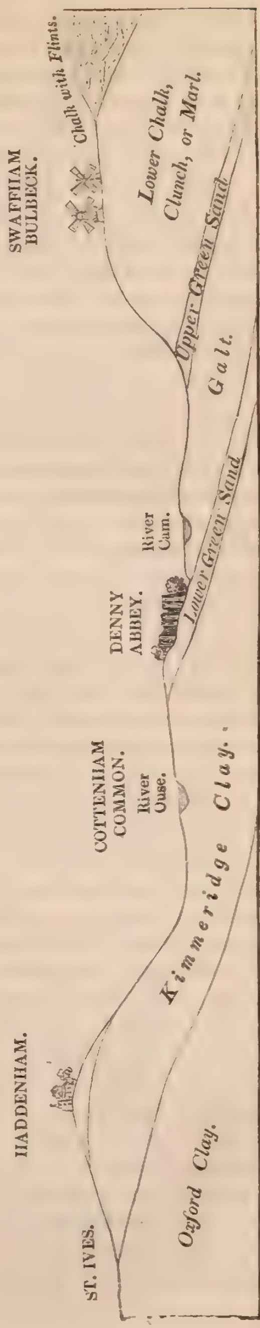
The soil of the county of Cambridge has, on the east, a substratum of chalk, being a continuation of the chalk formation of Essex; which cropping out at Ickleton, Meldreth, Royston, Newton, and Gog-Magog hill, near Cambridge, passes on by Newmarket to the county of Suffolk. This chalk formation extends from Royston into the heart of the county—to Melbourne, Shepreth, Newton, and Shelford. At Cherry Hinton, Burwell, and Swaffham, the lower chalk formation crops out; and here we find splendid land of a soft soapy nature, excellent for wheat. The whole of this chalk formation is covered with diluvial deposits of sand, gravel, loam, tenacious clays, and various other strata, either in beds uninterrupted for considerable space, or in every variety of admixture.

The western side of the county, adjoining Huntingdonshire and Bedfordshire, consists of a brown diluvial clay at Gamlingay, resting on the lower greensand, which crops out in the village of Gransden: and here also the Oxford clay makes its appearance. At Orwell-gap we find an outlying bed of chalk; and at Madingley-hill we have another. These are quite separated and detached from the great range of chalk-hills forming the north side of the London basin.

The brown diluvial deposit at Gransden rests on the lower greensand; at Longstow, &c., it rests upon the galt; at Coton, on the chalk-hill; at Madingley, the galt crops out on the north side, and then the Oxford clay forms the substratum; at Haddenham the lower greensand crops out; and as you descend towards Cottenham Fen you lose this, and the Kimmeridge clay makes its appearance; at Denny Abbey the lower greensand again appears. Crossing the river Cam towards Swaffham, you have the galt, which continues to Swaffham. Here we find some splendid land on the lower chalk formation; and on the eastern side of Swaffham the upper chalk crops out. This chalk deposit is of various thicknesses: at Saffron Walden, near the borders of the county of Cambridge, the late lamented Mr. Jabez Gibson bored to the depth of 1001 feet, and did not get through the chalk.

The northern part of the county consists of low flat fen-land, with a deep deposit of vegetable matter resting on the Kimmeridge and Oxford clays. That portion of the fens abutting on the blowing sands of Norfolk is of the worst description, containing a large portion of sand and white particles of chalk. I





From Haddenham to Swaffham by Denny Abbey.

am indebted to Mr. Deck, of Cambridge, for two sections of the soil of this county, which I have annexed.

The principal rivers are the Cam or Granta, and the Ouse: the latter river is navigable from Cambridge to Lynn, in Norfolk, to which port large quantities of the grain-produce of this county hitherto have been sent by this navigation; but it will soon be a question whether the corn-produce will not in future travel to London by the railroad.

The southern and central part of the county, extending from Ickleton to the north side of Newmarket, is light land, consisting of chalk, sands, tender loams, and gravels.

The eastern side of the county, adjoining parts of the counties of Essex and Suffolk, up to Chevely, near Newmarket, is heavy clay land of various qualities, nearly the whole of which district requires draining.

The western side of the county, adjoining Bedfordshire, Hertfordshire, and Huntingdonshire, consists of a tough tenacious clay, of little value on the hills, but the flats are good, strong, deep, staple lands.

In the northern part of the county the Isle of Ely is situated, which consists of the fen district, an accumulation of vegetable deposit resting on the fen-clay.

I will divide the county into four districts, and treat of the system of farming, carried on in each, by itself.

Few counties, if any, have improved more in cultivation than Cambridgeshire has lately done. All the open common-fields have been enclosed (with the exception of five or six parishes), and instead of a system of cropping so exhausting to the land as a fallow and two white-straw crops in succession, with other men's flocks of sheep eating up your food and preventing improvement, we now see the land farmed on the four-course system—the best that can be adopted, unless on very fine land. Large flocks of sheep (not barely kept in existence, as heretofore) are fattened with corn and cake for the London markets, thus enriching the land and increasing its productive powers. In the farm-yards and sheds we now find beasts fattening on corn and cake, &c., raising large quantities of rich and valuable manure to be carried back to the land again, to stimulate and renovate her for greater exertion, when she will, with much more gratitude than mankind generally evince, exert herself to repay, with interest, the kindness and attention shown her. But formerly, in these yards you found only a few straw-fed cows nearly starved to death, and verifying the old adage, that "if an animal eats straw, it voids straw." Comparing the present system with the former, it is astonishing to mark the increased wealth our present improved system brings to the state; not only thus largely increasing the national wealth,

but also giving full employment for our labourers, which is the only means of producing a happy and contented peasantry: and, if not out of place, I would wish to draw the attention of the landed proprietors and my brother farmers to the great benefit to themselves and their country that must follow the full employment of our labourers. It is the bounden duty of owners of landed property to see that all who are willing to work have the means of obtaining an honest livelihood, as it is the duty of the farmers to provide them with such means. If this principle were fully carried out, it would tend more to improve the social system and strengthen the framework of society, than any other steps that can be taken. And so long as the occupiers of the soil receive remuneration for the employment of their skill and capital, so long are they bound to strain every nerve to produce sufficient food for a largely increased and fast-increasing population. Now, much as the produce of this county has been increased (and the increase, I admit, is great), still I feel no hesitation in saying that a wide field is yet open before us; and although on many farms improvements and high farming have been carried on to the full extent that can be done with safety to the tenant, yet other farms and districts are as yet badly cultivated. I should like to ask to whom is the credit due for past improvement? Why, to the energy, zeal, and perseverance of the tenant farmers, who by the judicious application of capital have rendered vast tracts of comparatively barren land productive. But this can only be done under the security of long leases and good faith between landlord and tenant; for if the tenant, even under the security of a long lease, has, by a very considerable outlay of capital, permanently improved his farm, greatly augmenting its productive powers, and the landlord, at the expiration of that lease, takes unfair advantage of the tenant's improvements by demanding a largely increased rent, surely no one need be surprised if the tenant farmers do not fearlessly carry on those permanent improvements to a greater extent.

I shall now proceed to treat of the system of farming carried on in the light land district, which commences at Royston, on the south-west border of the county; and at Ickleton, on the south-east, running in a northward direction beyond Newmarket to the border of the county of Suffolk; and in an eastern direction to Linton. The western ends of the parishes of Balsham, West Wratting, Weston Coleville, Carlton, Brinkly, Westly, Dullingham, and Stechworth, all abutting upon the Newmarket and London road, are light, tender, weak lands, consisting of diluvial deposits of sands and gravels on chalk; whilst the lands round the villages, and in an eastern direction, are heavy clay and mixed soil lands. On the western side of the district we include part

of the parish of Guilden Morden, and Odissy, Litlington, parts of Bassingbourne and Kneesworth, Meldrith, Melbourne, Shepreth, Foulmire, Foxton, Newton, Hauxton, Harston, Trumpington, Cherry Hinton, Bottisham, Swaffham, Burwell, to Fordham. In the five last-mentioned parishes we find a large portion of the soil to consist of a good deep, soapy, white loam, lying upon chalk or clunch. This is the lower chalk formation, and is capable of growing large crops of wheat; in fact, it is as fine wheat land as I ever saw. The great objection to this soil is, that it poaches when feeding off the turnips with sheep; but with our improved plan of cutting the turnips this great difficulty is obviated. The rest of this district consists of a portion of chalk land, some very thin-skinned, hungry gravel, and sand, on a dry, thirsty, walling-stone. Near the rivers and brooks we have occasionally moory and black sand on a gravelly bottom or subsoil, full of springs; some small, tough, tenacious clay spots, mixed with a deposit of fine chalk and sand, all of which require draining, and most of which have been drained. A part of the parish of Melbourne, and a small part of the parish of Foulmire adjoining, are of a similar description to the white lands of Burwell, &c., which lie in a low situation, and are extremely valuable and productive with judicious management. It is on this description of soil that a few years ago the much-prized seed wheat, called the Burwell wheat, was grown. The whole of this district is farmed on the four-course system, with very few variations. Writing a Report on the farming of my own county, and being personally acquainted with most of the best farmers residing in it, I feel it would be inexpedient to treat of any one's farming in particular. I shall, therefore, only speak of the system and course of cropping pursued, and not of individual farming. The cropping generally pursued is—

First year, fallow for turnip, rape, or mangold-wurzel.
Second, barley.
Third, seeds, tares, or peas.
Fourth, wheat or oats.

First Year—Fallow.

The manner of preparing land for turnips, &c., pursued by our best farmers, is as follows:—As soon as any of the wheat lands are cleared in harvest, to commence ploughing them up on those parts intended for swedish turnips and mangold-wurzel; first taking care to have the wheat mown or reaped sufficiently low to allow of ploughing immediately after the crop is carried, without having to wait for haulming the stubble. This land, as soon as time will allow, is again ploughed across, by some, in large flat

works; by others, in the manner we term striking, or back-bouting. This is done by turning one furrow to the land, and in returning to turn over this furrow, and the furrow or earth on which it was laid, so that it lies all in gatherings for the frost to enter and pulverize it. As soon as the weather is fine and dry these lands are dragged across with a harrow, called the Staffordshire harrow, which is certainly the best implement I ever saw for getting out couch-grass or root-weeds. Those who have had Finlayson's harrows have discontinued using them, and prefer the Staffordshire harrow, which requires four horses to work it. A set of common harrows follow the Staffordshire, then a light roll, followed by another set of common harrows, then a set of one-horse, light, jingling harrows. The couch and roots are all thus brought to the surface, and then picked up by women and children, and burnt. These operations should only be carried on when the land is so thoroughly dry that the dust will fly about; and it is a complete waste of horses' time to do such work at any time when the land is not perfectly dry. Many farmers collect the burnt ashes and mix with bones or guano, and drill with the turnip or rape, for which purpose they are very valuable. But unquestionably the good they may do in this will not repay for the previous exhaustion they had caused to the land. I have seen some farmers drilling in burnt couch-ashes mixed with bones, and giving the land a good dressing; but yet they had so imperfectly cleansed the land from the couch-grass, that by the time it came round for fallow again an abundant supply of couch would be afforded for producing ashes for the same purpose. I consider when the land is fallowed it should be thoroughly cleansed from all couch-grass, &c.; for, in fact, every weed that grows extracts as much nourishment from the soil as would produce an ear of corn. It is the sandy and gravelly soils which are so much subject to couch-grass. On the chalky soils, so subject to charlock, this plan of striking on to bouts will be found the most effectual manner of causing the dormant seeds to vegetate in the spring. And here I must admit I am quite ashamed of my county; for notwithstanding its most excellent farming in many parts, we still continue to be disgusted in the spring by witnessing whole fields of barley as yellow as saffron from the charlock when in blossom; whereas by strict attention for a few years, *never allowing a head to seed,* they might be, as I have known them to be by many of my friends and neighbours, *completely eradicated.*

After all the couch and roots have been thus destroyed, and the few annuals allowed to vegetate, another good ploughing is given, the land being first marked out into proper-sized lands, and in the direction intended for it to lie. We thus have the first,

second, and third earths of the fallow, ploughed each time in a different direction to the preceding one. This earth, after lying a few days, according to the dryness of the weather, but not long enough to get hard and cloddy, is then rolled down and harrowed, making a fine tilth for the annual weeds to vegetate in. The dung is then carted on the land and spread, and immediately ploughed in: and here too much care cannot be taken in having the dung in good order, and well shaken and broken in pieces in spreading, so as to be well covered by the plough. Some of our farmers set the dung on the preceding earth, and drag it out before the last earth is given with the Staffordshire harrow: it is by this plan better incorporated with the soil, and less exposed to the action of the air: and some few of our best farmers have adopted the Northumberland plan, by putting them on the ridge; but the plan has not been followed by many, as it is generally considered, on our *dry*, *thirsty* soils, that we do better *on the flat*. On land in the least tenacious and approaching to clay, I consider the ridge plan advisable; but not on our very dry soils. The turnips are then drilled with about 3 or 4 lbs. of seed per acre of swedes. Skirving's improved Liverpool is the sort now generally sown, as they produce a greater weight per acre, and are of a good quality—two very great essentials in a turnip-crop. On the white or chalky soils the swedes are drilled about the last week in May; or warmer soils, about the 11th of June: all the early sown have been the best this year.

Where the land is dunged for turnips, many of our best farmers also apply a dressing of light compost, consisting of bones mixed with burnt weeds or coal-ashes. The writer of this report generally pays about 60*l.* annually for wood-ashes, which are collected in the winter, and mixed with bones and burnt ashes; and although he fattens a great number of beasts on cake, &c., for the purpose of raising rich farm-yard manure, he never drills an acre of turnips or rape without a slight dressing of bones and ashes, guano, or rape-dust; and this on about 400 acres annually. I feel bound to state that every experiment I have made with guano, or seen made by others, has answered my most sanguine expectations. Nearly in the centre of this turnip district we have two very extensive and most excellent bone-mills, situated at Duxford and Whitlesford, belonging to Mr. Charles Thurnall; and I feel I shall not be out of place in stating him to be the son of the late and ever-to-be-lamented William Thurnall, than whom no man ever was more beloved and respected whilst living, or more deeply lamented and regretted when dead, by the whole body of farmers in the county of Cambridge. The demand for bones has so increased of late years, that they have advanced in price from 15*s.* to 23*s.* per quarter; still the large importations,

and the more general use of guano, has not only checked their advance, but slightly lowered the price; and I am induced to hope that, from the beneficial results I have seen from the use of sulphuric acid in dissolving bones, and by using a less quantity per acre, we may still further reduce them.

As soon as the turnips are sufficiently old they are harrowed across with an iron harrow, made expressly for that purpose, with two rows of teeth only, which parts and thins the turnips without smothering them up, as is the case with the common harrow; the turnips are then either horse-hoed or flat-hoed by hand, costing about 2*s.* 6*d.* to 3*s.* per acre; they are then set out singly, each hoer having a boy or girl following him to part and pull up any he may have left, so as to leave them single. And farmers will find that too much attention cannot possibly be paid to this part of the business, to see that each turnip stands singly, and that they are not left too thick; as neither large turnips nor a great weight per acre can be grown without plenty of room between the plants, so as freely to admit the air. Some drill them 17 inches from row to row, others 21 inches. The advantage of having them 21 inches is, that in horse-hoeing them the horses walk between the middle rows of plants, but at 17 inches they are obliged to walk on the middle row of plants, which is a great objection. The plants are left rather nearer each other when drilled at 21 inches. In about three weeks' time they are again hoed by hand, to see that all are left single, and to stir the earth and cut up what few weeds may be found. Our lands are subject to rye-grass, and if not kept well attended to in fine weather, and in the early stage of growth, cannot be kept thoroughly clean afterwards. But the turnip-crop should be kept as clean as a garden, not allowing a weed to make its appearance.

About one-fourth or one-fifth of the turnips are pulled and carted into the yard, to be consumed by beasts eating oil-cake and meal. The greater portion of those which remain are then consumed on the land by fattening sheep, eating cake or corn. Many will suppose that with such high farming great crops would be produced, but this district is generally of so poor and hungry a nature that without such high farming scarcely any crops would be produced. The natural value of a large portion of this district is, comparatively speaking, nothing without high farming; and the increased produce that has been grown since the various parishes have been inclosed is truly wonderful.

The readers of this Report can easily picture to themselves the great improvement that must have taken place by the highly improved system of farming at present carried on with so much spirit, as compared with that thus described by Mr. Gooch, in his

Report on this county in 1806, at page 97:—"A farmer states, that he thinks fallows should lie whole all winter, even if intended for turnips, and that the first ploughing should not be later than May." Many swedes are now *sown* in May. At page 146 he states, "The cultivation of turnips was much confined in the county, owing to so great a part of it having been open field, the system of cropping which, and the flock-master's right of going over the whole fallow-field, precluding it;" and "that turnips do not succeed on chalks." The writer of this Report has seen on chalks as good swedes as on the red lands; and had, this year, much better swedes on his white land than on his red. I should think in Mr. Gooch's time the turnips went off (as he states) for the want of manure to make them grow, as I find only muck and fold were then used, and those of a bad description, and the seed was generally sown broadcast, in a few instances only were they drilled; and one person is named as using light compost; a Mr. Shepherd, of Chippenham, at that time used eight bushels of rape-dust per acre, with the drill, for turnips. At page 147, Mr. Gooch states, "Hoeing twice; but as the art is not well known by the inhabitants, the work is done by persons who travel the country for that purpose, and who make great earnings. It cost a farmer in the neighbourhood of Wimpole 25*s.* per acre in the year 1803 for hoeing his turnips by his own people, who would not take them by the acre, but did them by the day, and, it was thought, wrought hard." The price now, for hoeing twice, is about 7*s.* or 7*s.* 6*d.* per acre. Large breadths of rape are grown, which do not require sowing until the beginning of July, or to the middle of that month. This gives an opportunity of cleaning any portion of the fallow shift that has become foul; and it is generally admitted that better swedes are grown by changing the shifts, letting swedes succeed the rape and white turnip, and so on alternately; and in fact this point cannot be too much attended to in every course of cropping—changing of soil and seed. The practice of cutting the turnips for sheep is much on the increase. Some pull all their turnips by about Christmas, that is, those that are intended for fat sheep: those required for early feeding are well cleaned, and the tops and tails cut off; they are thrown into heaps of about 20 to 30 bushels, covered with a slight coat of straw or haulm and a few moulds. This costs, for cleaning and heaping, independent of the covering up, from 6*s.* to 7*s.* per acre. Another plan, adopted for those for late feeding, is to draw four drills right and left, thus clearing the space; the plough then opens a double furrow, and about seven rows of the turnips are put in this furrow, and with the plough covered up with four furrows, two on each side the turnips; this is done for about 3*s.* to 3*s.* 6*d.* per acre, besides the cost of ploughing;

these rows should then be looked over, and, with a shovel, a little earth put over any portion not well covered up with the plough. These are ploughed out in the spring, cleaned, and thrown in heaps ready for cutting for the sheep. Another plan is to pull them, and take only the leaves off, and heap them, and cover with straw and earth, and clean them as required for use. Others heap them in small heaps just as pulled up, and cover with straw and earth. By some they are pulled and set upright on the ground, close to each other, in a round bed, and the edge of the outside row covered with a few moulds of earth. In bad sharp weather a little haulm or straw is scattered over the tops. Each plan has its advocates; but the great secret in keeping them is *not to cover them up too close, as they are sure to heat and rot if they have not sufficient air.* Less damage will be sustained from the covering being slight than when well covered up: the top of the heaps should have no earth put on them, so as to admit air.

The land intended for mangold-wurzel is twice ploughed and scarified, the same as the turnip land, and put on to the bout or ridge in the autumn, then dunged in the spring. These ridges are then split down, rolled with a very light roll, the seed either drilled or dibbled. The mangold is stored for stock ewes, fat sheep, and beasts, and not used till late in the spring, bearing in mind that a careful attention to provide sufficient food of this kind for the spring enables the farmer to keep off his seeds until they are sufficiently advanced to carry his stock on well. Some farmers have a portion of the turnips carted on to a piece of fallow which has a plant of self-sown trefoil, or white clover, it having been seeded when in the seed-shift the previous year to the wheat crop. These turnips are either ploughed into furrows or clumped up in about 30-bushel heaps, great care being taken not to have the tails cut off, and only just the leaves taken off, not cutting into the crown of the turnips, and then covered with straw and earth. Mangold is also clumped in a similar manner, for the purpose of feeding with sheep in the spring. This plan has two advantages: it enables the farmer to get off his barley land a week or two earlier, and to keep off his seeds a week or two later; and these are two objects that cannot be too much attended to by occupiers of light land, for by sowing late on our turnip lands we suffer considerably in our crop of barley, and by being under the necessity of turning out on our seeds before they are got sufficiently a-head, we suffer for the remainder of the season, and can scarcely get a full fair bite again. Many sow a warm, well-sheltered, quick-growing piece of land with rye and the early Essex winter tare mixed, two bushels of rye and one bushel of tares per acre. This is used for the ewes and

lambs in the spring, to eat with turnips and mangold carted on to the sides of the field in the autumn, and clumped ready for the spring.

I feel bound, in justice to an agricultural implement-maker of this neighbourhood, to state that he has succeeded in making an apparatus for dropping bones and other light composts with turnips, and which is easily applicable to any common compost-drill. It was invented by that intelligent and clever agricultural implement-maker, R. Maynard, of Whitlesford. Several pieces of turnips were dropped with it last year and the preceding one: I dropped with it this season and the last about 60 acres, and am bound to speak well of it. The compost is dropped regularly at 14 inches from heap to heap; a prong or fork covers up the bones, &c., a light coulter with the seed follows, and a small parcel of seeds are deposited over the drop or heap of bones; thus having a few moulds between the bones and seed, the turnips are not dropped opposite to each other, but diagonally.

The liberal prize of twenty guineas offered by the excellent president of the Saffron-Walden Agricultural Society (Lord Braybrooke) was this year awarded to a piece of swedes dropped with Maynard's drop-drill; and the successful competitor had to contend against seven of the best turnip-farmers of the district. Several of our farmers last year tried charcoal broken for turnips, but not with sufficient success to induce them to continue the practice.

The sort of sheep generally kept a few years ago were the white-faced long-wools; but downs, or short-wools, have increased considerably of late years, and are now generally kept. Probably their increase is owing in a great degree to our having in this county one of the first and most justly celebrated breeders of Southdown sheep in existence, Mr. Jonas Webb, to whom this county, and the country at large, are so much indebted for the spirited manner in which he has improved the breed of this truly valuable stock of sheep; and the extraordinary high average price for which he has for so many years continued to let such large numbers, is strong evidence of the estimation in which his blood is held by the best breeders of Southdowns and the public in general.

I have been credibly informed, that not a very great many years ago broken-mouthed wether sheep have been actually purchased for fattening; but now the lambs are put to high feed early, are wintered with corn and cake on the rape and turnips, and are made quite fat at the age of 14 to 16 months; weighing more per quarter, I will answer for it, than the old broken-mouthed wether did when made as fat as the system then pursued would do. On most farms a flock of breeding ewes is kept, the wether lambs

of which are fatted, being shorn once, and sold when at the age of 14 to 16 months; these, after the rape is all consumed, have turnips cut into troughs, and, I feel confident, the plan of cutting turnips for sheep wants only to be tried by those who even now object to it, to be by them most readily adopted. As soon as the fleeces are taken off the backs of the hoggets, they are sent to the London market.

Second Year—Barley.

As the turnips or rape are consumed by the sheep, the lands are clean ploughed for barley. Some have of late been in the habit of striking the lands on to bouts, and after lying some time for the frost to pulverize. they are scarified across and ploughed again on the flat in the spring. But I do not think the practice is attended with sufficient success to justify the expense. It is a well known fact, that ploughing light land does not increase its fertility. I do not so much object to this plan on early-sown rape, as it prevents the stalks growing through the interstices of the ploughed furrows, which is often the case when the land is only ploughed once on the flat, and particularly if done by bad ploughmen. The lands in the spring are well harrowed, and drilled with from three to four bushels of barley per acre.

The varieties generally sown are Chevalier, Potter's, and the Nottingham Long Ear: the latter sort has extended much of late. A set of light harrows follows to cover the seed. The small seeds are sown with either a wide light drill or a handbarrow; this is done by many at the time of sowing the barley, and by others soon after the barley is up, harrowing the seed in with a very light set of jingling harrows with wooden teeth. Some people object to sowing the seeds the same time as the barley, but by so doing we are sure to secure a plant of seeds, which is of the greatest importance on this description of soil; for without a good plant we cannot ensure a good plant of wheat. The objection to this early sowing is, that the seeds are apt to get up too much in the barley, and in a wet harvest prevent its drying so rapidly, thus causing some delay in the carting. I agree, that on the heavy clay land it is not advisable to sow thus early, as the above objections bear more strongly on such land: lying, too, in small fields, and not so much exposed as in our more open part of the country, the seeds, especially red clover, grow more luxuriantly on the clays than on our dry sterile soils. But on the latter description of land, with very large open fields and no hedge-row timber, every breath of air comes over the swarths and dries them. The slight danger and loss thus sustained in a wet harvest is, in my opinion, more than compensated by the safety and security we feel in regard to our plant of seeds. I consider the two great maxims to

be adopted by the occupier of light land are, first, to obtain the heaviest crop of turnips he possibly can, at the least expense ; this secures a crop of barley: secondly, to secure a good plant of seeds, which will ensure a good plant of wheat.

The plan of not sowing the seeds mixed is extending, as it is found the lands are getting "clover sick." Many of our best farmers now sow red clover only once in 16 years, getting the seed-shift into the following rotation ;—1st, white clover ; 2nd, trefoil ; 3rd, peas or tares, fed off or seeded ; 4th, red clover. Thus only can we now obtain good crops of red clover.

The quantity of red clover sown per acre is from 15 to 20 lbs. ; of white clover, from 12 to 20 lbs. ; of trefoil, from 25 to 30 lbs. per acre. This district is a fine barley country, sending to the large malting towns of Bishop-Stortford and Ware vast quantities of the very finest description of malting barley.

Third Year—Clover, Peas, or Tares.

Some of the clovers are dunged in the winter for mowing for hay ; the rest generally sheep-fed. Some of each variety are left for seed by some farmers, and it is desirable to do so to a certain extent, not so much in consequence of the return as for the purpose of enabling us to give a winter's employment to men with large families ; the parents threshing or cobbing the straw, the children being employed in rubbing out the seed on what is called a clover-rubber, which is made about 6 feet long by 3 feet wide, and the bottom made with tin plates full of holes punched inwards, so that the rough side is like a nutmeg-grater, only the holes considerably larger. In this district a portion of the trefoil is left for a crop, and if got well in fine weather, the straw is very useful for the winter foddering of horses instead of hay ; and in this district, where so little grass-land is found, and that not of a good quality, it proves a very useful substitute. As soon as the harvest is over, and that portion of the fallow intended for swedes and mangold ploughed up, they commence ploughing the seed-layers for wheat, and this is done as shallow as possible, and kept well rolled down with a heavy roll after the ploughs. Some use a drill-roll, with four horses : I believe it is impossible to get the lands for wheat too solid on these dry light soils.

Fourth Year—Wheat.

The land having been well rolled down, it is now well harrowed, and the seed drilled with from 2 to 3 bushels per acre of wheat, as we are obliged to sow thus thick, particularly on the dry chalky hills. Those parts of the layer that are neither dunged nor folded have generally from 3 coombs to 2 quarters of rape-

dust * per acre drilled in with the seed. Some have lately tried nitrate of soda sown as a top-dressing, but do not continue the practice.

This district being surrounded by tracts of heavy clay, backward land, the labourers from thence, at the time of year the wheat is ready for the sickle, flock into it in large numbers, so that it is no uncommon thing to see a man's whole crop of wheat cut down in four or five days. I have set about 300 men to reaping in one day. The barley and oat crops are put out to the men of the district, who are bound to cart and stack the wheat. The practice of mowing wheat has much increased of late years, and it will, in my opinion, extend, as the practice of early autumnal fallowing increases. The reaping of wheat generally costs from 7*s*. to 10*s*. per acre, with beer, the latter price being given to have it cut close to the ground.

The wheats on many of these dry chalky soils are very apt to lose plant in the spring. On this description of land many farmers have their flocks of store ewes driven over the wheat after it is finished drilling, and tread the land down as close as possible: but this should not be done in very wet weather; for in the year 1842, which was a very wet season, during and for a long time after sowing, much of the wheat, from being trodden down in the wet, and great quantities of rain falling afterwards, did not vegetate: it was as it were hermetically sealed, and thus deprived of the action of air and light: large quantities of the seed lay and rotted without any appearance of vegetation.

But few cows are kept in this district for dairy purposes, as it contains but a very small portion of grass-land, and this only on the banks of the Granta or its tributary streams.

The descriptions of cattle fatted are of various kinds. The short-horns, Herefords, a few Devons, occasionally a few Welsh runts, and polled Galloway Scots: none do better than this last sort for feeding loose in yards; but even when kept loose in yards they should always be tied up three times a day, so that each bullock has its own share of food, as you will generally find some masterful hungry bullock will get much more than his share, and if fed high will consequently get off his appetite for

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* Rape-dust drilled in with wheat appears to be most efficacious in preserving the plant on those light lands, where it is apt to die off towards the end of winter. A striking instance of this occurred on my own farm this year. On some poor land out of condition, where three bushels of wheat had been sown to the acre, with various manures and with dung, the ground was almost bare in March, excepting on one bout of the drill, where I found rape-dust had been used, and there no loss of plant had ensued. I mention this case, because the evil of losing the plant of wheat upon such light land is a severe one, and because the proposed remedy, rape-dust, is not an expensive manure.—PH. PUSEY.

some days. They are fed with turnips, mangold, cake, and corn.

A neighbour of mine, and one of our best farmers, fed last year, in consequence of the low price of wheat, his beasts with boiled wheat: the beasts did remarkably well, and became excellent meat.

A landed proprietor, Mr. Cotton, of Hildersham, who has been growing the Gold of Pleasure, had the oil extracted at the mill, and cakes for feeding made with the refuse. He has fed his beasts with it this winter; they have done well with it, he informs me, and he has used the oil for his own domestic purposes: it burns well, gives a good light, and has no offensive smell. I hope he will furnish our Society with a full account of the results.

The Second District

Is the heavy land district on the eastern side of the county, adjoining the counties of Essex and Suffolk, and running to Chevely near Newmarket, consisting of part only of the parishes of Balsham, Wratting, Weston, Carlton, Brinkly, Westly, Dullingham, and Stetchworth; these parishes about the village and on the eastern side are heavy land: the boundary of these parishes is long and narrow, running down to the Newmarket road, so that nearly all the land lying on the western side of the village is light land; all the villages adjoining the counties of Essex and Suffolk are heavy lands, requiring hollow-draining. I shall now proceed to treat of this district as distinct from the heavy land district on the western side of the county, as it is in my opinion much better managed, particularly as relates to draining. It is, with very few exceptions, farmed on the four-course system; it is all well hollow-drained, and generally speaking well farmed. The parishes of Horseheath, Castle Camps, and Sheedy Camps have a fair portion of good grass-land.

First Year—Fallow.

The lands of this district, being heavy and requiring draining, are generally ploughed into stetches containing eight furrows, so that in drilling the horses walk in the furrows; thus are avoided the treading and poaching so injurious to heavy land, which is the great fault in the management of the western district, for there they have the lands all on high backs, and from one to two rods wide. The plan pursued by the best farmers of this district is, after wheat or oats, the land coming for fallow, the old furrows are opened with a pair of horses; then, with three horses abreast, the ploughman turns a furrow on to the edge of each of the furrow-slices thrown out of the old furrows, thus leaving in the middle of each land a baulk, containing two furrows, which

the ploughman then splits: thus the ridges, or lands, are made one yard wide; the four furrows thus ploughed out of the middle of the stetch then lie two furrows right and left, lapping on to the furrow-slices thrown out of the old furrows; they are then called three-furrow ridges, as each ridge is thus made one yard wide with three furrows. As soon as the land is quite dry in the spring, these lands are struck down by going one bout on each land; this plan stirs that portion of the ridge that was not removed the previous earth; they are then well harrowed, and the charlock and needles, &c. allowed to vegetate; again harrowed, then the land is ploughed across on large wide lands with three horses, one going before two; and when done in hot dry weather (and it is a sign of good husbandry in this district never to plough the land in wet weather after winter, as the treading and poaching of the horses' feet do more injury than all the after ploughing can rectify), the practice of ploughing the land very deep for this earth has considerably increased of late, and from my own observations I cannot believe it possible to plough too deep. The utility of ploughing deep on all retentive soils must be evident to all, for if the soil be only ploughed shallow in very wet weather it gets unfit for vegetation, the water becomes stagnant, and soluble matter in the soil is either washed out or locked up, from being so thoroughly soaked as to exclude the air; and when it gets dry it is as hard and solid as bricks ready for burning. In either case it is almost impossible for any plants to vegetate properly, the soil being at one time wet and soft, and at another too dry and hard. But when the soil is artificially increased by deep ploughing, the rain gradually sinks down the whole depth of the furrows into the substratum, thus moved, and from thence into the hollow drains, and in hot dry summers the deep-ploughed ground will hold, by capillary attraction, a much greater supply of moisture for the nourishment of plants. Thus deep ploughing drains off the water during heavy rains, and supplies the means of healthy vegetation at all times. It is found by experience that the deeper land is ploughed for fallow, the sooner the water percolates through the soil into the drains. The depth of the staple by these deep ploughings is also increased. After this deep ploughing the lands are dragged with a heavy crab-harrow; in about three weeks ploughed back again, a good depth, with three horses; again crab-harrowed and harrowed with common harrows; then with a double-breasted plough the land is marked out into lands of the exact width of the drill, and the uniform size of each land is preserved by a marker or piece of wood being fastened on to the beam of the plough by a bolt going through the end, so as to allow its being turned over at the land's end: at the end of the marker is a small iron bar, sharpened at both

ends, each point being about 2 feet 6 inches from the end of the marker; at the end of the marker is a chain attached, which hooks into the end of the horse's whippletree. This marker is by the ploughman turned over at the land's end, and hooked in the end of the other whippletree, the ploughman returning in the mark previously made by the marker.

These lands are then ploughed with two horses, and one more ploughing is given soon after Michaelmas, the last two furrows being ploughed with two horses at length, to prevent any treading of the ploughed land. Water-furrows are then drawn. In the spring no more ploughing, but a large iron skim covering the whole stetch is used, which cuts the loose land previously pulverized by the frost. A set of harrows follows, then the drill; then a set of light harrows covers the seed. The land then lies like an onion-bed. How far preferable this plan to the old-fashioned one of ploughing the land in the spring, and sowing the barley broadcast: not a horse's foot by this plan treads on the land, all going in the furrows. The portion of land intended for seeds is sown after the barley is up, and either rolled or harrowed in with a very light set of harrows, some merely using a hurdle with a few bushes drawn through the bars. Red clover is taken once in eight or twelve years; beans, peas, and tares fed off on the rest of the seed-shift.

On this soil the manner of drawing the drains for hollow draining is to have them with a fair fall for the water; and they are generally, I might say always, drawn slanting across the lands or ridges, and running in parallel lines to each other at distances varying from 4 to 7 yards; but the nearer the drains to each other, and the deeper they are put in, the drier the land, and the greater the advantage to the occupier. The drains are drawn by some with a common foot-plough; by others with a very large plough made for that purpose, with larger and much deeper mould-boards or breasts. The ploughman first draws out four furrows, leaving a baulk of two furrows, which are thrown out as deep and as wide as possible; then a furrow is taken out of the bottom open furrow: thus we get a depth from 8 to 10 inches. The mains are then drawn out at the ends of the common drains, and an opening to every six or seven score rods of common drain is made into the open ditch, which should be well cleaned out before operations are commenced. The drainer begins by necking in these parts of the main drains, which is done with a common trustle-spade about 10 inches deep and 6 wide: two spits deep are dug out with this common spade: each drainer has a boy with a pail, and a half-pint tin mug fixed in the end of a stick, and with this he pours a few drops of water on the edge of the spade, which materially assists the workman in cutting his

ditch out clean. This applies more to the lower spit, which is cut out with a narrow draining-spade,* about $1\frac{1}{2}$ inch wide at the lower end, and 12 to 16 inches deep. The moulds left are all cleaned out with a bent scoop or hoe. The workman as he proceeds in his main necks each common ditch as he comes to it: these mains are dug about 2 inches deeper than the common drain. The drains are then filled up with bushes and straw or turf cut from the fens in the Isle of Ely; and some are done by ramming the lower spit of clay on to bridges drawn along the bottom of the drain. When filled up with wood and straw, great care should be taken in the manner of putting the bushes and wood in, so as not to meet the current of water: the wood is pressed in the drains by a crotch stick, and the side boughs and crooked parts have a slight cut made with the bill, so as to make them more readily yield to the pressure of the stick: this prevents the breaking and putting in of the sides of the drains. A little straw is scattered on the top of the wood, and pressed on it, and by the best farmers great care is taken in filling the earth in: the lower spits are taken up with the hand and laid upon the straw, and trod down with the foot. The objection stated to filling in with the shovel until this is done, is, that the sides of the furrows of the surface-soil roll in first; and as soon as the straw and bushes decay, this, not being of so adhesive a nature, falls to the bottom of the ditch and creates an impediment, and at such places the ditches are apt to blow up. But by the tough clay spits being put in first, they settle down, by treading at first, and afterwards by pressure, close over the straw; and when the straw and wood decay, form a compact arch, leaving a hollow space for the water to flow. The plan pursued when filled up with turf is by the workman going forwards and laying the turf in the drains: the ends of the turf should touch each other; these are pressed in with the foot of the drainer as he proceeds, and the ditches being cut tapering, getting narrow below, they act as a complete wedge, and leave a hollow space below of about 5 inches deep. These pieces of turf are cut about 14 inches long.

The method adopted in ramming is to make bridges consisting of four pieces of oak plank, about 5 to 6 inches deep, and nearly the size of the drain, not fitting too tight, but just filling up the

* This narrow spade, or lance-headed tool, though probably it has been used for at least a century in the eastern counties, I have found superior to any other for laying inch-pipes in a tenacious clay free from stones. As compared with the long-handled tool used in my own neighbourhood, it enables one workman to do the work of two, and with greater ease. The use of it is peculiar, as two side-cuts are made and then a cross-cut, but is easily learnt, and the tool is a favourite with workmen who know it.—Ph. Pusey.

space; these pieces of plank are jointed with iron hinges or joints; the lower spit is rammed on them. The bridges are then drawn forward by a lever attached to a chain fastened to the bridge or plug; earthen pipes or tiles are put in the mouth of each eye or neck running into the open ditches.

Third Year—Clover, Beans, Peas, or Tares.

The red clovers are fed with sheep on those portions intended for seed up to the 1st of June. It is not considered safe to feed them later, as it injures the crop. The part intended to be mown for hay is mostly covered with a mixture of dung, and borders and scourings of ditches mixed up together; this is carted on the clover layers in the frost, and well harrowed in with a bush-harrow.

The lands intended for peas and beans are ploughed in the winter, so as to be well pulverized by the frosts: early in the spring the peas are drilled. Many plough later, and with a hand-barrow deposit the peas on the bottom of each alternate furrow. The beans are either drilled or dibbled. Peas, about 3 bushels per acre sown; beans, from 2 to 2½ bushels per acre. The beans are hoed three times, and I have seen field after field kept as clean as a garden.

Fourth Year—Wheat.

Wheat succeeds both clover and beans and peas, but the wheat after peas is much more hazardous. Both the bean and pea land should be sown later with wheat, and not quite so much seed per acre sown as when succeeding clover.

Mangold-wurzel and swede turnips are occasionally grown in this district, the land selected for that purpose being generally land lately converted from grass to arable, or a piece of mixed soil land. No good can be done by growing turnips generally on the heavy clays of this district. I will here mention a plan pursued by a proprietor occupying his own estate; and it is a plan worthy the consideration of those farming this description of land.

The plan alluded to is to plough the land after wheat on the eight-furrowed ridge, twice if necessary, during dry weather in autumn or winter. These ridges are in April split with the plough; the manure then spread and ploughed in, as on the Northumberland system. These ridges are then not disturbed until the time of sowing the turnips, when a skim is used about 3 feet wide, with a sharp edge attached to a pair of gallows, like a Kentish plough, thus cutting under the manure of every ridge. This operation destroys all annual weeds; the earth is in a beautiful pulverized state; the seed drilled upon it grows well and with rapidity. Good turnips are thus produced, for feeding on

the land in dry weather, or for drawing off. I think if turnips are grown on heavy land they should always be drawn off, and the land sown with wheat, as I believe wheat succeeds better after turnip or mangold than either barley or oats on such land. This district contains a fair portion of good grass-land. Several spirited farmers have lately been rearing suckling calves; they get the best short-horn calves they can, brought up out of Northamptonshire, which are fed with milk and boiled linseed, &c., having a warm shed to go into, and a run into some rich young grass; as soon as they can eat it they have a little linseed cake allowed, are so kept the summer, are well wintered on cake and turnips, turned out to grass the following spring, having cake every day, and are then fit for the butcher, being made fat about the age of 20 months to 24 months.

No one can travel through this district and the heavy clay district on the western side of the county without being struck with the superiority of the system here pursued over the other—both being heavy clays and requiring draining. In the eastern district every field being ploughed in straight lands of one uniform width to fit the drill, all treading and poaching are thus avoided. The great advantages also of cross-ploughing the fallow, and when fresh drains are required, of being able to put these drains across the former old ones, are not to be lost sight of. In the western district we have nearly all the lands on the high backs, scarcely any of them straight lands, but varying in width from 5 to 10 yards, and when the land requires fresh draining, the drains must be put in the same furrows as before and in the same direction; no deep cross-ploughings can be given, but always ploughing in the same direction. I cannot but think that the day is not far distant when we shall find the example now being set by Mr. Franks, of Childerly (who manages Colonel Calvert's estate), in getting the lands gradually ploughed down and sized into straight uniform lands, generally adopted.

The Third District

Consists of the parishes lying on the western side of the county, abutting on Bedfordshire, Hertfordshire, and Huntingdonshire, commencing at Guilden Morden, and running in a northward direction by Whaddon, Barrington, Harlton, Barton, Granchester, and crossing the turnpike-road leading from Cambridge to Huntingdon, and proceeding in the same direction until it joins the Fen District, gradually becoming better and stronger land as it nears the fen. Those parishes abutting upon the first or light land district are also good useful land; so also is that portion adjoining Hertfordshire—the Abingtons, Wendy, and Shingay,

and the flat or lower portion of the parish of Tadlow, and a portion of Wimpole and Orwell.

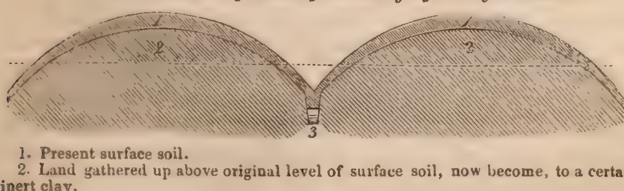
The land is of a good deep staple from these villages to the western side of the county: as you ascend the range of hills you find the soil of a thin staple and very poor, resting upon a tough, retentive, tenacious, clayey subsoil of little value, and which has not as yet been well farmed. You here perceive the plan our forefathers adopted to get rid of the water; for instead of taking the water from the land, they endeavoured to take the land from the water. And this they endeavoured to do by ploughing the land on to what is now called high backs. The plan adopted was to begin to plough by commencing in the middle of the land, or gathering; and they have thus for centuries continued to gather up the land. They gather up twice and split once. These lands, formerly lying in the common-field state, are ploughed of all sizes, and running in every direction, none scarcely being found that are straight; and since the enclosures of the various parishes they have been continued in the same form and shape. The plan is to hollow-drain up the furrows of each land. In fact, they cannot drain in any other direction, in consequence of the high elevation of the ridge of each land.

I am well aware it may justly be said none are so well acquainted with the best system of farming land of any description in any locality as those who have been situated on the spot all their lives. Yet allow me to draw attention to the vast improvements that have taken place in nearly every district and description of soil within the last half-century. Look what claying and draining have done for the fens; it has so consolidated and condensed the lands, as to render that which was formerly of little worth now the most productive and valuable soil of any in the kingdom.

See what bones and guano, &c. have done for the thin-skinned, poor, light, hungry lands. Observe the neatness of the heavy land district on the eastern side of the county, every field being ploughed straight on the 3 or 6 feet lands, no horses being allowed to walk on the land, all going in the furrows. But it is not so in this western district: here both horses and carts must tread and poach on the land. I am well aware it is contended you would ruin the land by ploughing it down and getting it flat, so as to be able to plough on any sized lands we pleased, or drain it in any direction. I know that it is stated by practical men of the district that we should get the furrows too strong, while the middle or heading of the stetch would grow little or nothing. Supposing their observations to be correct, it most fully proves to me the advantages of deep ploughing on these heavy lands, for the present soil of the furrows consists entirely of the original

subsoil; yet by constantly ploughing deeper, the action of the sun, air, and frost have made it, in appearance and texture, like that of the surface soil. Yet if we split these lands down so as to get them level, we are told the present furrows would become too strong: this could only be done by the staple or surface soil being made so much deeper by the plough. What can more clearly or convincingly convey to any reflecting mind the great advantages of deep ploughing on heavy land than this very fact—for I admit such would be the result—that it *would* be stronger in the old furrows? But I would soon endeavour to make the present heading or gathering as good, by deep ploughing and the application of manure. I am confident the advantages of ploughing deep on this description of soil are incalculable; it deepens the staple, it more readily drains the soil, and affords better nourishment for plants. I well recollect, in my early days, that the green sides of a heavy clay lane, abutting upon my father's property in Suffolk, were dug off at three different periods, until at last nothing was left but the tough tenacious clay subsoil. A few years afterwards, several of his labourers living in his cottages near the spot, asked his consent, and obtained permission, to enclose this land for gardens. A quick was planted, the land divided into allotments, and although, poor fellows, they had nothing but solid clay to commence operations in, by thorough draining it and deep digging (for then they double-dug, or trenched it), with the application of manure, and good and deep culture, these allotments are now as fine gardens as I wish to see, producing everything very early in the season, and full also of thrifty and growing fruit-trees. On these high-back lands, I contend that the gathering up, or centre of each land, by not having been exposed to the action of sun or air for centuries, has become dead, inert clay; yes, even that portion which was the original surface soil: and I prove it thus;—by digging across lands of this description, I have always found the soil lying in the following manner:—

Section of Ends of Lands lying on high Backs.



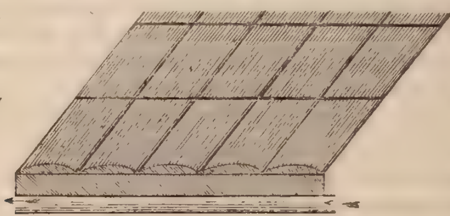
Level of original surface soil.

1. Present surface soil.
2. Land gathered up above original level of surface soil, now become, to a certain extent, dead inert clay.
3. Hollow drain up the middle of old furrows.

The middle portion of the land now gathered up above the original level of surface soil is now found, a certain portion of the centre, to have become dead inert clay, from having lain for cen-

turies deprived of the action of the air and sun; and the furrows, and sides of furrows, much below the original bottom of surface soil, are now become, by being moved by the plough, and by the action of the frost and summer's sun, fair surface soil.

If these lands were ploughed down and got level, as they would have been in the eastern district, they would lie in the following manner; and the following sketch will at once clearly show the advantage of the latter system:



These lands are two yards wide, and made to fit the drill.

In riding over several thousand acres in the month of December, I found only three men hollow-draining; two were on the estate of Lord Hardwicke, at Wimpole, putting in drain-tiles on very flat land, 7 yards apart and only 21 inches deep; the other was on the hill near Hatley—he was at work upon one of the old furrows of a high-backed field, with lands two rods wide, and putting the drains in only 14 inches deep, filling up with haulm and bushes cut from the hedge-row border. This surely could not be looked upon as a very expensive improvement; yet it is wonderful what great improvement is effected even by this imperfect and partial attempt at draining. In the flats of the parish of Tadlow, &c., I found draining going on in every direction, and the land appeared to be well farmed. A large portion of this district belongs to Downing College; and I think they would much benefit their tenants, without injuring the estate, were they to remove all the hedge-row timber, and allow the width of the hedge-rows to be lessened, as the injury sustained from hedge-row timber is incalculable. From Wimpole to Hatley I found a large tract of land very badly cultivated, not only covered with thistles, couch-grass, &c., but sadly in want of that first and great improvement on heavy clays, viz. thorough draining. It certainly was a description of land that would repay the least for outlay of capital; but so long as such lands are kept in cultivation, it is only by the judicious application of capital and good farming that any return for the capital employed can be made: and unless such soils are well thorough-drained, well ploughed, and kept clean, their occupiers cannot, I am confident, realize a profit. It was a bad sort to have in hand, and appeared to me to require a

considerable outlay of capital to get it in good order. On the estate at Childerly, belonging to Colonel Calvert (which is an entire parish, containing 1050 acres of land; has no church, nor any poor, as the population does not amount to more than 50), I found considerable improvements going on, under the able superintendence of his intelligent bailiff, Mr. Franks. Some well arranged and well constructed sheds for fattening beasts had just been erected, and about 100 beasts eating oil-cake, &c. Mr. Franks grows about 20 or 30 acres of turnips or mangold every year; this he does on the newest or strongest land. With these, and the hay grown on the farm, with the addition of about 200 tons of cake consumed by beasts and sheep, he is improving this estate. He does not attempt to winter sheep on this cold clay soil; but in the spring and summer months stocks heavily with sheep, fed with cake; and in the two years it has been under his management he has laid down 260,000 drain-tiles, and intends putting down half that number this year. He is also gradually ploughing the lands down off the high backs, and shaping them into lands more convenient for the drill. I saw some of his wheat on land lying as tight and as level as on the best cultivated heavy clay districts of Suffolk. He farms this on the four-course system, and it is the course of cropping generally pursued in the whole district.

I consider that on the poorest portion of it, if instead of growing beans they grew tares, and fed them off on the land with sheep, eating corn or cake, it would much improve the land; and, in my opinion, by so doing for a term of years, the land would not only be improved, but the total proceeds would be increased. But the first great improvement to be adopted in this district is thorough draining; and surely the expense can be no excuse for not effectually doing it; this district lying nearly all on the high backs, which are lands varying from 7 to 15 yards wide, and the hollow drain being made up the furrows only, there cannot be more than from 4 to 6 score rods of draining per acre to pay for: the bushes they fill up with are cut from the hedges; the haulm or stubble to cover up with, left in the field; so that the expense of doing this work cannot be very heavy.

I believe I am justified in claiming for this county the honour of being the first county in England into which irrigation was introduced: the history of it is remarkable. Pallavicino, who was collector of Peter's Pence in England at the death of Queen Mary, having 30,000*l.* or 40,000*l.* in his hands, turned Protestant on the accession of Queen Elizabeth, and appropriated the money to his own use, buying with it the estate at Babraham, near Bournbridge, and procuring a grant from the crown of the river which passes through them, he was enabled to build a sluice

across it, and use the waters for the purpose of irrigation. The quantity of land thus watered is about 300 acres, and although an interval of 287 years has elapsed since this introduction of irrigation, I think I am correct in stating that this example has not been followed in any instance in the neighbourhood, except on the banks of the Cam, on the borders of the county at Littlebury, in Essex, on the well managed estate of Lord Braybrooke: in this instance the waters of the Cam are used, as well as a small tributary stream running from Saffron-Walden, the water of which is considerably improved by the drainage from the sewers of the town. The quantity of grass produced by this system, and in this case, is extraordinary. These works are well executed, and do great credit to the noble proprietor.*

The estate at Babraham is now in possession of Mr. Adeane; and I would point out this village as worthy a visit from any of my brother farmers, as one in which they would find lands of little or no natural fertility rendered productive by the judicious application of capital, employed in carrying out the most improved systems of cultivation; and I will pledge my word to them that they will be well repaid for a day's journey. The time of our landed proprietors would not be wasted in also paying this village a visit: they would find all the cottages clean and neatly built, and would have strong evidence of a degree of comfort and cleanliness not to be excelled, if equalled, throughout the kingdom. Celebrated as Babraham no doubt was in the time of Queen Elizabeth, in consequence of the first introduction of irrigation, it has now, in the time of Queen Victoria, become of much greater note by being the parish in which a tenant of Mr. Adeane's has reared and produced some of the best blood of Southdown sheep, from which the celebrated Babraham flock takes its name. Mr. Jonas Webb commenced his annual business of letting tups in the year 1823; and most people are aware with what success his efforts to improve the breed have been crowned. He lets nearly 200 rams annually, and has been one of the most successful breeders of Southdown sheep. May he long be spared to his family and country to carry on the improvement in the breed of these useful animals!

The breed of Southdown sheep has much increased in this county of late years: several still prefer the white-faced Leicester or Lincoln. I neither like to see them on my land nor on my table.

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* On my return from our Meeting at Derby, I availed myself of the opportunity to go over the watered meadows at Clipston Park, belonging to the Duke of Portland, and I there saw really barren waste land made most valuable by irrigation: there, indeed, were seen the art, science, and ingenuity of man crowned with triumphant success.

On the chalky soils of this county large breadths of sainfoin are grown, and a most valuable article it is: it will yield a good crop of hay for wintering horses, and for cutting into chaff for sheep; and the rowen is most valuable for lambs. It is a general rule not to feed it down too close with sheep, as it injures the next year's crop. It is sown with the barley in the spring, drilled in with 4 bushels of seed per acre. Many farmers lay down the poorest portion of the farm with this useful plant; but I consider nothing would pay better than getting such land into good order and good heart, before laying down with sainfoin: nor can such land be got too clean, as it is apt to get covered with fiorin-grass after lying a few years. It will not stand more than nine years, and a practice is now much gaining ground of feeding and folding it close the last year with sheep, and ploughing it up and sowing it with wheat. This plan has been very successful.

A new variety of sainfoin has lately been introduced in some parts of this county, and has been exceedingly well spoken of; it is called the gigantic sainfoin. The seed has been selling as high as four guineas per bushel; it grows with a broader leaf, is much earlier, and cuts a heavy crop.

A plan has of late been most highly commended by all who have tried it, and the practice has also much extended. They sow sainfoin in the regular course of the four-course system, instead of seeds, for one year's layer only, to be mown for hay and fed close with sheep, then ploughed up for wheat the next year, with the rest of the regular seed-shift. This plan was first introduced into this county in the neighbourhood of Mildenhall. The difficulty of getting a plant of seeds, from the land becoming clover-sick, led to an experiment of this kind with sainfoin, and its having been attended with great success has led many others to follow the plan. It is stated, by those who have tried it, that they not only get a fair crop of hay, and good after-feed for sheep, but that wheat is sure to succeed well after it, of which I have no doubt. But I cannot say I feel much inclined to adopt the system: I endeavour to prevent my lands from becoming clover-sick, by not sowing mixed seeds, having one portion red clover, another white clover, another trefoil, and the remainder peas or tares mown for hay, fed off or seeded; and after the peas and tares, take oats instead of wheat. It appears to me, that after getting a good plant of sainfoin, to plough it up the first year must be attended with a loss; for after having been at the expense to seed your land, we know that the second, third, fourth, and fifth years will each nearly, if not quite, double the quantity of hay that was produced the first year, and this without any further expense except rent, tithe, and rates, and the cost of mowing, making, and carrying. I would, therefore, much prefer letting

it remain one whole rotation, if not more, and plough up the laye for wheat after the first year of the succeeding course. This would bring it into the regular four-course shift or course again after four years.

The Isle of Ely, or Fen District.

The difficulty I feel in writing on the farming of this county is considerably increased in consequence of a large portion of it consisting of fen-land, being so different in every respect from any other part of the county. But I have, by a careful view of this district at various times, and by communications with some of its most spirited cultivators, endeavoured to obtain, and I trust have obtained, sufficient information on the subject. Yet I feel that none but those brought up, living in, and cultivating this district, can fairly and fully do justice to it. It is a wonderfully fine district, and one in which more improvement has taken place within a few years than in any other. I think a district so important deserves and is entitled to a separate Report.

I will endeavour to give a full account of its original state, as described by various writers, and of its state at the present moment. Mr. Atkins (a Commissioner of Sewers in the reign of James I., 1604) states, that in his opinion the fens were once of the nature of land meadows, fruitful, healthful, and very gainful to the inhabitants, and yielded much relief to the high-land countries in the time of great drought."

Sir W. Dugdale, about 1644, says, "that great numbers of timber-trees grew there, as was plain from many found in digging canals and drains, some of them severed from their roots, the roots standing as they grew in firm earth below the moor: fir-trees at the depth of four and five feet, but the oaks at three; they were found lying in a north-west direction, not cut down, but burnt near the ground, as the ends of them being coaled manifested. The oaks in multitudes of an enormous size, being five yards in compass and sixteen long, and some smaller, of a great length, with a quantity of acorns near them. About a mile westward of Magdalen Bridge, in setting down a sluice at seventeen feet deep, several furzes, and nut-trees, pressed flat down, with nuts firm and sound lying by them, the bushes and trees standing in the solid earth below the silt." Dugdale also mentions a gravel causeway three feet deep, supposed to have been made by the Emperor Severus, who was born 146, and died 211, from Denver in Norfolk to Peterborough in Northamptonshire, twenty-four miles in length, which is now covered with moor five feet in thickness. In deepening the channel of Wisbeach River, 1635, the workmen, at eight feet below the then bed of the river, discovered a second bottom,

which was stony, with seven boats lying in it covered with silt. And at Whittelsea, in digging through the moor at eight feet deep, a perfect soil was found, with swarths of grass lying on it as they were first mown.

Henry of Huntingdon, in the reign of Stephen, 1135, described this fen country as pleasant and agreeable to the eye, and watered by many rivers which ran through it, diversified by many large and small lakes, and adorned by many woods and islands. And William of Malmesbury, in the time of Henry II., 1154, in writing of the lands round Thorney, says, "It is a very paradise in pleasure and delight; it resembles heaven itself, the very marshes abounding in trees, whose height without knots do emulate the stars. The plain there is as level as the sea, which, with the flourishing of the grass, allureth the eye."

It appears that all sorts of trees are found buried in the uplands, but mostly oaks; in the lower fen-lands they are all firs. The horns of red-deer, acorns, and nuts are found in various parts of the fen. The inundation of the fens or level district arises from various causes. First, the waters flowing from the uplands through the various rivers, which, from the want of being properly scoured out, were constantly overflowing their banks; and in addition, the rain poured its waters upon the smooth and porous portion. This, in addition to the already overburthened accumulations from the uplands, laid this district under water; which, however, would not happen unless inwinter, or at least, seldom in summer. But the greatest addition was the daily flux of the tides driving from the German Ocean through the harbours of Lynn, Wisbeach, and Boston, into the defenceless and over-burthened level. These waters would naturally overflow to a considerable distance the surface of a flat country, and we may also suppose an accumulation of sand and silt at the mouths of the rivers, the constant recurrence of the tides preventing the regular discharge of the floods collected from the upland and downfal waters. Thus, the waters of the ocean, mingled with those of the heavens and the springs of the earth, passed over the whole of what was then, in its most extended sense, the great level of the fens, consisting of about 300,000 acres.

Soon the attention of the enterprising was drawn to this immense tract of rich land; but to undertake to drain such a vast extent of country must at these early periods have been a work of formidable magnitude. Yet even then public-spirited and enterprising men were found, with genius to plan and perseverance to carry into effect works so extensive, being indeed no less than cutting one entire new river, in the first instance, 25 miles long and 100 feet wide.

In 1605 a Bill was introduced into the House of Commons

for draining certain fens and low grounds within the Isle of Ely and country adjoining, being 300,000 acres, but was rejected on the third reading.

In the year 1607 the "Little Bill" for 6000 acres of fen land, called Waldersea Country, was passed. This was the first District Act for draining the fens. There, as in the fens generally, after many years windmills were erected for pumping the waters up to the level of the river from the low lands below: this was only done imperfectly. In going over this district in 1846, I was informed that previous to the erection of the powerful steam-engine which drains it by throwing the waters into the river Nene, at certain periods of the year boats went over the land, which was the habitation of large quantities of wild-fowl. But immediately after the erection of this engine the lands were laid dry, and splendid crops of corn grown the first year. I was over this land just in a flood, and the lands were as dry as any in the upland part of the country; I might say drier, for I found the plough going in most parts of the fen, although the rain had fallen in such quantities that we were not moving a plough on our dry chalk and gravelly soils. I looked upon this as strong evidence of their effectual system of draining. This steam-engine was erected in 1832; it is of 60-horse power. The waters are raised by a pump six feet in diameter, and it lifts 46 barrels of water each stroke, and can take from six to ten strokes per minute, according to the height of tide in the river. It had that morning been raising the water 20 feet, so that at the time of high flood the water in the river Nene stood 20 feet above the level of the water in the drains in the level fen below. This engine, with buildings, cost about 3000*l.*; the coal to work it costs about 150*l.* per annum. It drains 6500 acres of as fine land as I ever saw, the drainage-tax on which is 4*s.* 6*d.* per acre. When the mortgage-debt is discharged, a portion of which is done annually, the tax can be reduced to 1*s.* 6*d.* per acre.

In 1630 a contract was entered into with the Earl of Bedford, called the Lynn Law, sanctioned by the Commissioners of Sewers, and enrolled in the Court of Chancery. The Earl was to have 95,000 acres of the drained lands for his satisfaction, on account of the expenses and hazard consequent on such a work. In this he was joined by thirteen gentlemen adventurers. In order to carry off the superfluous waters wherewith the level was so much annoyed, from causes previously stated, the Earl and his associates caused numerous channels or drains to be made.

1. Bedford River (now called the Old Bedford River), extending from Earith to Salter's Well, 70 feet wide and 21 miles in length.
2. Sam's Cut, from Feltwell, in Norfolk, to the River Ouse.

3. A Cut near Ely, now called Sandy or Sandall's Cut, 2 miles long, and 40 feet wide.
4. Bevill's Leam, being a cut from Whittlesey Meer to Guyhirn, about 10 miles in length, and 40 feet in breadth.
5. Morton's Leam was connected with these works, but this cut had been made as early as 1478, by Morton, Bishop of Ely. It was 40 feet wide, and 4 in depth, and extended from Peterborough to Guyhirn, a distance of about 12 miles.
6. Penkirk Drain, 10 miles in length and 17 feet in breadth.
7. New South Eau, from Crowland to Clow's Cross.
8. Hill's Cut, near Peterborough, about 2 miles in length, and 50 feet in breadth.
9. Shire Drain, from Clow's Cross to Tyd, and so on to the sea.

Besides these cuts and drains, they caused two sluices to be made at Tyd, upon Shire Drain, to keep out the tides; and also a clow at Clow's Cross for the fresh water; and likewise a great sasse at the end of Well Creek, where it empties itself into the river Ouse at a place called Salter's Lode, to keep out the tides; and another sluice at Earith to keep out the floods; but above all (says Dugdale), that great stone sluice below Wisbeach, at the Horseshoe, which cost about 8000*l.*, to hold the tides out of Morton's Leam.

In 1649 the Act for draining the great level of the fens was passed. This vast tract of fen country extended itself into the counties of Northampton, Norfolk, Suffolk, Lincoln, Cambridge, Huntingdon, and the Isle of Ely, and consisted, as before stated, of 311,000 acres.

In 1650 Sir Cornelius Vermuyden, a Zealander, was appointed Director of the great works of draining the fens. He commenced operations by dividing the level into three parts—the north, the middle, and the south, by which names they are distinguished and known at the present day. Each of these levels has its particular rivers, banks, works of drainage, and outfalls to the sea.

These immense works were not carried on without considerable interruptions and temporary delays, occasioned by failure of pecuniary resources and the requisite number of labourers; and to surmount the latter difficulty, in 1650 arrangements were made by which a large number of the Scotch prisoners taken at the battle of Dunbar were employed in completing these stupendous works. In 1652, of the Dutch prisoners taken by Admiral Blake, 500 were also employed. And thus the result of war was made to contribute to the redeeming of a vast extent of new territory, which we now see affording employment for thousands in the peaceful occupations of rural life, thus rendering that which was formerly valueless now the most valuable and

productive land in the United Kingdom. And to prove of how little value it was at this period, we find that in 1651 the Earl of Arundel sold his lands in the fens, consisting of 5900 acres, to William Stephens, Esq., of the Middle Temple, for the sum of 3*s.* 9*d.* per acre, the total purchase being for 1032*l.* 16*s.* This was no bad investment, for the land now lets, I suppose, at about 7000*l.* per annum. On the 25th of March, 1653, the adjudication of lands to the adventurers took place, on which occasion a general thanksgiving was offered in the Cathedral Church at Ely, in humble gratitude to heaven for the completion of these works.

Soon after the year 1726 a plan of private drainage by legislative enactment was commenced, and an Act passed "for the effectual draining and preserving of Haddenham Level in the Isle of Ely." From this period may be dated the plan of draining by mills. The windmills, however, erected in this district have been pulled down, and a powerful steam-engine erected, which most effectually drains the fine fen lands of that parish.

After the general erection of windmills, the plan soon adopted was what is called double lifts—that is, first one large mill is erected near the main river, and then a smaller one at some distance behind: the one mill by first raising the water from the mill drain a certain height, and in certain quantities, lessens what is called the head of water to be thrown by the first mill, and greatly facilitates its operation.

The artificial system of drainage, under the authority of local district acts, by the means of water-engines, may be thus explained:—Certain proprietors of any given quantity of land agree to apply to Parliament for a local act. The boundary is set forth, and sub-division dikes are made, for draining the estate of each owner. These division-ditches empty themselves into a main drain, cut at the general expense of the owners (commonly called the mill-drain), and run through the whole district, which is embanked all around by a mound of earth, raised to a height proportioned to the quantity required to be excluded. The mill-drain terminates at one end, near a river, upon the banks of which the water-mill is erected; and thus by means of a circular wheel the water which has found its way into the mill-drain is thrown from thence into the river, from whence it passes to the outfall, and onwards to the sea. The number of mills in each district depends upon the extent, and the head or quantity of water required to be discharged.

The steam-engines now erected in the fen district of this county are ten in number; besides some private ones.

1st. In the district of Littleport and Downham we have two very powerful steam-engines, one standing on the banks of the New Bedford

River, which is an 80-horse power engine, which raises by a water-wheel about 40,000 gallons of water per minute, lifting it about 12 feet high.

2. The other engine stands on the banks of the ten miles river, and is of similar power. These two engines drain most effectually about 23,000 acres of fine fen land. One old man about sixty informed me that he perfectly recollects, before these engines were erected, that he had known this district flooded three times to the depth of from six to seven feet.

3. The steam-engine at Waldersea Fen, before fully described.

4. One at Bene, or Bageney Fen.

5. Another at West Fen.

6. Mepal engine, 80-horse power pump-engine, drains about 13,000 acres, the tax for which is 3*s.* 6*d.* per acre.

7. Over steam-engine, 12-horse power.

8. Haddenham } on the banks of the Ouse.
9. Cottenham }

10. Swaffham, on the banks of the Cam.

It did appear to me surprising that in this age of improvement 5000 acres of fine land should still be left liable to be covered with water in any flood—I mean the reservoir or space between the banks of the two great rivers, or artificial drains, called the Old and New Bedford Rivers. Of course as an upland farmer I am entirely unacquainted with the management of fen land, and totally ignorant of the difficulties that prevent the accomplishment of so desirable an object: but great difficulties I presume there must be; or with the proof before their eyes of the advantages of arable crops over the coarse, sour grass now grown on this land, the proprietors would long ere now have called science to their aid, and by her assistance rendered this a corn-producing district. But I have no doubt we shall, ere many years roll over our heads, see this made as dry and secure from floods as any of the surrounding lands—that is, if in future the prices for grain produce should be sufficiently high to stimulate them to do so. I am justified in the above observations by the opinion expressed by the intelligent registrar of the fen district, Mr. Wells, whose urbanity and kindness in freely giving the information I sought on the subject of the drainage of the fens, I beg gratefully to acknowledge.

I rode through the whole of this district in January, with a friend. We had a flooded time, and my own farm, as I have mentioned, was so wet at the time that I did not move a plough for days; yet I found this fen district so perfectly drained that they were ploughing and carting on the land, and claying the soil. I saw men at work in holes 7 to 8 feet deep, and only requiring the use of a small scoop to throw the water out of the holes occasionally. In nearly the whole of the low flat portion of the level of the fens the soil consists of a deep deposit of vegetable matter,

or bears' muck, as it is called in the district. This turf consists of the congeries of the roots and fibres of a great number of different species of plants. It is found varying in depths from 2 to 7 or 10 feet; it rests upon the Oxford or fen clay, which is almost without a stone in it, and is of a very soft nature, cutting out like butter by the men employed in claying. All the high lands of this district consist of diluvial deposits of sand, gravel and clay, either separate or mixed. At Haddenham and Waterbeach the lower green sand crops out. A portion of the fen district, abutting on the dry sandy soils of Norfolk and Suffolk, consists of a light, sandy, porous fen mould; and is, in my opinion, of less value than any other portion of the fen. I felt a great pride and satisfaction in riding over this district to see what the persevering spirit of British enterprise will undertake and successfully carry into execution; to know that two hundred years ago this large tract of rich country was deluged with water and valueless to the country, but now, by the judicious application of skill and capital, is rendered the most productive and most valuable land in this county. Grain crops succeed each other in succession for years, if kept clean, and this at comparatively little expense. The high lands surrounding this district where the diluvial deposit is of clay, are well hollow drained, which many years ago was done with turf; but they are now executing their hollow draining in a more effectual manner by the use of drain-tiles. Between Ely and Littleport is a fine tract of high land belonging to Mr. Layton, and in his own occupation, which is well farmed: he has a portion of fen land belonging to this estate, on which he has lately erected a steam-engine at his own expense, which completely drains his fen land. At the foot of this skirt or high land is a large drain called the Catch-Water Drain, which conducts the waters running off his high land into the river, so as to prevent its running off his high land in time of floods into the fen land below. This considerably facilitates the operations of the steam-engine, as it greatly lessens the quantity of water for it to throw. He has a very fine brick and tile kiln on his estate, adjoining the turnpike-road from Ely to Wisbeach, close to which passes a navigable canal. He has made some most excellent drain-tiles with soles, and some pipes with a foot or flat bottom attached, to act as a sole for them to rest on. Mr. Layton uses these tiles for draining his heavy clays on his high lands.

Near Ely is Grunty Fen, consisting of 1280 acres lying in the seven parishes of Ely, Witchford, Wentworth, Haddenham, Wilburton, Streatham, and Thetford, into which fen the several inhabitants of each village turn cattle or sheep, without any restriction or limit as to numbers. This fen would make most excellent arable land; but the difficulty appears to me insur-

mountable as to enclosing it, and I fear it is doomed to remain as a lasting monument or evidence to show of what little value the surrounding lands would have been if left in the same state.

From Ely, through Littleport, to the banks of the Bedford River, is a fine tract of well-cultivated land. Around Littleport village high land of good quality and a tract of fen land running down the river or 100-feet cut. At Welney we passed over a beautiful suspension bridge, erected at the sole charge of the Rev. William Gale Townley, the rector of Upwell This structure does great credit to the taste of the projector. The road or causeway from this bridge to the one over the Old Bedford River is nearly three-quarters of a mile in length, and stood about 2 to 3 feet under water. This was a portion of the Washes before described. At Welney we found a continuation of the fine fen soil, but it did not appear to be so well drained as at Littleport. Between Welney and Upwell we crossed the new cutting for the Middle Level Drainage, which commences at St. German's Bridge, running to the 60-feet drain; they are cutting it 60 feet wide, and about 15 deep: it will be 11 miles long to the 60-feet river, which will be deepened; and this is intended also to lay dry the great meer at Whittlesea, which contains about 1000 acres. From Wisbeach to March, we passed through a district of splendid fen land, a portion of which is still drained by windmills. From March, Wimblington, and Doddington to Chatteris, the road passes on the ridge of diluvial deposits of gravel and clay. A portion of this district is also still left to the uncertain power of wind for its drainage. I must express my great surprise that land of so much value should be left to the uncertainty of this power. I feel no doubt but that in a few years we shall see nothing but steam-engines used for that purpose.

At Willingham we observed a large tract of land partially inundated, from the want of a mill to throw off the water: the old windmill was in a dilapidated state and useless. The enclosure of this parish was going on, and it is intended to erect a steam-engine to drain the fen land of this parish. Rampton parish is newly inclosed; some part of the land is a wet clay, and requires hollow draining: that which was done appeared badly executed; it wanted, I considered, a few main drains, or deep ditches, to carry off the water.

The improvement that has taken place within the last few years in this district of the fen, by a system of drainage and claying the lands, is truly wonderful. Draining condenses the land, and claying consolidates it.

In all the farm-yards you find large quantities of cattle, and the plan adopted is to give them straw in the yards, and from 2 to 3 lbs. of linseed cake per day; these are therefore only kept

in good store order all winter, and sold in the spring. Those who have any high land, with good grazing ground on it, fatten them in the summer; but the greater portion of them are sold and sent into the fine grazing counties of Leicester and Northampton. The fen land does not answer well for grass, consequently but little grass land is found in the district, only on the uplands, and here we have some very fine grazing land. In the whole of this fen district the surface soil consists of a light, porous, vegetable matter, through which the water most easily percolates, until it reaches the clay; and so freely does it do so that in digging the holes for claying, the water appears to keep trickling from the pipes or hollow tubes of the undecomposed vegetable matter: as soon as you get into the clay no water oozes out; it is as it were impervious to wet, but the water lies as in a sponge in the vegetable mould above.

The great difficulty in describing the system of cropping pursued in this district is that no regular or uniform system is adopted. They have so much natural or virgin strength, that with some farmers it appears their whole study is how to tame it down; and this they endeavour by making wheat succeed wheat, then oats, again wheat (with some), wheat again, then oats, then wheat, then seeds, then wheat, then oats, then wheat; and by this time they may have got it so full of couch or twitch grass as to be induced to give it a rest, by following the old plan which used to be, after cropping some years, to lay it down with clover and grass seeds for three or four years; then to pare and burn, to take a crop of rape; then pursue another course or round of cropping. But this plan is fast giving way to the practice of letting them lie only one year in layer, which is mown for hay, and the aftermath fed with sheep. The plan pursued by the best farmers of this district is to fallow with rape or turnips, to which a dressing of bones is applied; and this is quite a new feature in fen-farming, but it is found that bones answer exceedingly well for rape or turnips on this soil. The rape is fed off with sheep, and this is done without hurdles. The rape is so strong and luxuriant, and stands so high, that the sheep eat as it were their way in, the outer boundary of the rape acting as a wall or fence against them. A portion of the turnips are drawn off for beasts in the yards. Sometimes wheat is sown after rape, but generally oats, as they are fearful it should be too strong for wheat; therefore we may say,

2nd	crop,	Oats.	7th	crop,	Wheat.
3rd	,,	Wheat.	8th	,,	Seeds one year.
4th	,,	Oats.	9th	,,	Wheat.
5th	,,	Wheat.	10th	,,	Oats or Fallow.
6th	,,	Oats.			

But the period in which it comes fallow depends much upon the clean state of the land, for it is rarely that it requires rest from exhaustion. It is extraordinary how well wheat succeeds after oats; and by the system of claying, the land is so consolidated that not only very large crops of wheat are grown, but of good quality also. The great difficulty they have to contend with is in getting rid of the oats that shell out on the land at harvest time; these they endeavour to make vegetate by harrowing and dressing the land. One plan by which they might easily get rid of them is one they dare not adopt—that is, by skeleton-ploughing or by the Kentish plan of broad sharing, which would too much loosen the soil, and their great aim and object is to keep the land as whole and close as possible. Great numbers of the Irish, after having assisted in reaping the early wheats in our warmer and earlier part of the county, flock into the Fens to assist them in their harvest operations; and a new-reclaimed territory like this is not yet sufficiently peopled for all the work required at the busiest periods of the year. On the uplands or skirt land they pursue nearly a similar course of cropping, but not so exhausting, as they are enabled to grow large crops of beans, of which great breadths are annually grown. Oats succeed the fallow, then wheat, then beans, wheat, oats, seeds, wheat, oats, fallow, or fallow after wheat; but they vary so much, according to the strength and cleanliness of the land, that it is impossible to describe a plan or course that is generally adopted.

Claying.

This is done by opening furrows in the field intended to be clayed, about 14 yards apart, parallel to each other. The workman commences at one end by sinking a hole about 5 feet long, and about 4 feet wide: this hole is sunk perpendicularly; and when he arrives at the clay, which varies in depth from the surface from 2 to 7 or 10 feet, he throws out about three spit, which is about 3 feet deep, of this clay on each side of the hole, half the clay on one side and half on the other. The vegetable matter that is dug out of the first hole is spread on the surface of the land; he then proceeds to sink holes or pits all up the furrows, about 1 foot from each other, so that this space thus left acts as a wedge to prevent the sides of the drain from slipping in. In digging the second hole, the peat earth is thrown into the first hole, and thus the moor or *bear's-muck* dug out of each hole is made to fill up the preceding one. The tools used for this work are—a small light shovel or spoon, with very thin sharp cutting edges, and about 12 to 14 inches deep—a light wooden shovel, made as a scoop, for throwing out the water as it runs into the

hole from the sides of the vegetable matter—and a bill or axe. And each man has on a large pair of fen-boots, which are made water-tight. Before the workman commences operations he drives a strong stake deep into the end of the drain, on to which a strong rope is fastened, with a noose tied full of knots; this hangs down the hole and by it. When he has finished by throwing out the quantity of clay required, he pulls himself up out of the pit. But sometimes the men are compelled to do so before the work is finished, in consequence of the drains slipping in upon them. The bill is in constant requisition to cut and clear out the stumps and roots of trees, which are found just upon the fen clay, thus evidently proving that this clay was the original surface of the soil, and that the vegetable matter had grown up and risen above them. But by the perfect system of drainage now adopted, the loose fen has been so much condensed that many of the old fenmen say the clay has risen, as it is much nearer the surface now than years ago, forgetting, as they do, that it is the condensation of this loose spongy soil which has brought the surface nearer the clay.

The lands are ploughed with a very light wooden plough, with a wide breast and a very wide share, about 12 inches wide, and it is but little labour for the horses. At the head of the plough is a foot rut, made of wood, and a wide piece of wood on the end, to prevent the plough going deep; if the foot was not wide, it would cut into the soil. The coulter is a circular piece of iron plate, sharp at the edges, which revolves and cuts through the vegetable mould. The corn is generally drilled in a workmanlike manner, and I never saw wheats looking better than they did in January. Few sheep are kept in this fen country. The portion of land in clover and rye grass is mown for hay, and the aftermath fed with sheep.

Ickleton, Feb. 22nd, 1846.

IV.—*On the Tussac Grass.* From the GOVERNOR of the FALKLAND ISLANDS to Viscount PALMERSTON.

MY LORD,—I have the honour to acknowledge the receipt of a note from your Lordship, dated 5th April, 1845, and have much pleasure in attending to the wishes therein expressed. I beg to state that the person who collects the Tussac seed is a poor man named C. J. Dettleff (a native of Hamburgh), whom I am encouraging to make a trade with it.

The price charged at present for the seed (50*s.* per pound) appears to be high, but it takes a long time and much care to collect,

as well as considerable personal inconvenience to the poor man, under the present circumstances of the colony.

The portion of your Lordship's property described in the note appears to be well suited for the growth of this grass, if the blowing sand be not more than two feet deep near the beach, and fortunately rest on peat or peaty soil, no matter how thin. If the shore be bold, and the sea-bank high and rocky, I should choose the most exposed points. If the spray, but not the actual wave, dashes over it, so much the better. I do not think that sowing it in the shifting sand would answer in the first instance, though when the grass once takes root in any soil, the drift-sand blowing over it, amongst it, and almost burying it, does not seem to injure it. I would try some in the sand that has been fixed by the bent, but as near the sea as possible. The Tussac loves the spray, and the finest plants are almost growing in the water. If the breezes from the sea carry a great quantity of moisture to the peat-bog behind the tract of sand, I conceive the Tussac grass would answer extremely well in it. We have Tussac grass growing on peat-bogs on exposed islands in the Falklands, in places 800 and 1000 feet above the sea; but these sites are exposed to the westerly gales, which are laden with moisture. Some of the finest young plants I have seen grew from seed sown in rich mould in my garden, 300 yards from the shore of a deep inland harbour, and protected from the winds by a high turf wall. This artificial mode seems to contradict what I before stated. Nature prefers the first-mentioned places; but as the latter is a fact, I would recommend both to be tried. In the garden I was so successful with the plants from seed, that I proceeded to transplant suckers from the wild ones on the rocky shore to the rich mould in the garden, and I found them to thrive vigorously. I took suckers from these again, also from the plants raised by seed, and planted out more rows. Every plant answered admirably. I cut them down, and they grew more bushy and spread, throwing out fresh suckers. I should soon have filled a paddock with the plants; but as it was necessary to change the site of the chief town, I had to abandon my garden, and begin new and arduous labours, which have occupied the time of all hands too much to spare any for experimental agriculture. In laying out a piece of ground for Tussac grass, the following circumstances must be borne in mind:—the plant grows in bunches occupying from 2 to 3, and sometimes even 5 feet in diameter, and the blades of grass when full grown are 7 or 8 feet long. The roots seem forced up from the ground, and I have been in patches of fine full-grown Tussac in which a man on horseback is almost concealed. I should therefore sow the seed in rows 2 feet apart, some in a garden, and some on exposed points of peaty soil close to the sea, and within reach of the

spray, carefully weeding between the plants as they grow up. When they are 9 inches or a foot high, the suckers might be separated and planted out 3 feet apart in rows. As the plants grow large, every alternate row should again be planted out, in order to leave room for a man, cow, or horse to pass between the rows without treading down the plants. To raise from seed appears a more uncertain and much slower method than that of planting out suckers from the finest plants.

With regard to the value of Tussac as a fodder, particularly for winter, I will mention a few facts that may be interesting. It is green all the year round; frost does not appear to injure it, nor does snow cover it; it is a soft, succulent, and highly nutritious grass, extremely relished by all animals—cattle, horses, sheep, and pigs. Cattle and horses fatten upon it in a surprising manner: they eat the whole blade down to the root, which, by the way, they relish most. They will eat old dry Tussac thatch from off the roofs of houses. The tracks of wild cattle and horses in the Falklands extend from many miles inland to the exposed sea-beaten points covered with Tussac. There is an island in Berkeley Sound that can be reached at low water from the main. The area of this island is as nearly as possible 800 acres, and there are about 400 acres of Tussac grass upon it: the remainder of the island is thinly covered with coarse wing-grass and rush on peat-bog—a very wretched piece of pasture land, affording scarcely any nutriment. Last autumn I caused the Government herd, consisting of 800 head of cattle and about 60 or 70 horses, to be placed on this island for the winter months. A small house is at the extremity of the ford, in which I placed a guard. The animals remained on the island nearly six months, with no other nutriment than what the island afforded. Towards the end of that time they began to get poor, and the Tussac was eaten down to the roots. By next autumn it will have entirely recovered. I am compelled to let the cattle graze the Tussac from want of hands and means to make different arrangements, nor do I consider any other plan a matter of sufficient moment in the present state of the colony to warrant the outlay requisite to economise properly this invaluable food; but in England, where labour is cheap, I would act differently. The cattle could be folded in an adjoining paddock to the field of Tussac, and fed over the wall or fence by men cutting the Tussac in bundles, commencing with the upper row and passing regularly through the field: by the time they had cut the last row, the first would be ready to cut again. Had such a plan been adopted by me in the island I mentioned above, I feel confident the 400 acres of Tussac would have amply supplied the 800 head of cattle for twelve instead of six months. It is incredible how much is injured by being trodden down and eaten too close; and

the horses, from preferring the root, do more mischief than the cattle. I have no data to say decidedly how many animals one man could cut food for in a day, and to attempt to do so might only mislead your Lordship.

I ought to mention that the plant is of slow growth, and would probably be three years in coming to perfection, during which period, however, it might be cut annually with advantage. When once full grown, it springs up rapidly after being cut down, the blades reaching their full height of 7 feet by the end of summer,

though cut down in the spring. I kept up a favourite horse in a loose box one winter, and had him fed entirely on Tussac, cut for him and given green. He ate it greedily, and was always in excellent condition; but as a general rule, I should consider it soft food for a horse doing any work.

When it is remembered that this invaluable provision of nature thrives luxuriantly where scarcely any other vegetation will exist—that it is most nutritious, and much relished by cattle, it is impossible to resist feeling the most earnest desire to see it extensively tried in those portions of the United Kingdom which in climate and soil bear some resemblance to the Falkland Islands. I might

easily expatiate on the extreme beauty of its vegetation, covering rocky storm-beaten promontories and small islands with a dark rich verdure, always reminding me of tropical luxuriance; but its importance in a practical point of view is what I am desirous of making fully known to your Lordship and to all interested in agricultural pursuits. I should wish to send a large quantity of Tussac seed to England every season, but the settlers here are as yet far too few in number and far too busy to spare time to collect it. It appears to me it would be money well laid out if one of our leading Agricultural Societies were to send here an intelligent person to remain the six summer months collecting seed. He would be absent from England about a year, and the whole expense would not exceed 300*l.* He should bring either a wooden or iron house, 10 feet square, with a small stove; three tons of coal; provisions, such as biscuit, pork, coffee and sugar; gunpowder, shot; warm clothing, bed and blankets; a folding table, two stools, and a military canteen. More things would be an incumbrance. Dettleff, whom I have mentioned above to your Lordship, usually goes from the settlement on foot, and takes only a good dog and a stick. He is absent about two months, sleeps under a rock, lives on wild geese and rabbits, and occasionally a calf, and invariably returns in the best possible health. A person from England might, however, fix his little residence on a small Tussac island close to the settlement, and at present reserved by Government, and in one summer collect such a quantity of seed, with Dettleff's aid, as would more than cover his expenses, to say nothing of the advantage of having a good authority at home, that could be referred to at any moment. I have given a close attention to this grass for four years; and though at first it may appear a dreamy kind of enthusiasm, I do not hesitate to say, that should it be found on trial to succeed in the United Kingdom as well as it does in the exposed portions of the Falkland Islands, it will raise the annual income of many landed proprietors from "hundreds" to "thousands." A Tussac-fed ox is in the finest order here at the end of the winter, though never housed or cared for in any way. In the *Falmouth Packet and Cornish Herald* newspaper, of the 23rd August, 1845, I have been shown a paragraph stating that J. Matheson, of Lewis and Achany, M.P., sent some Tussac grass seed, procured from the Falkland Islands, to Stornaway, and that Roderick Nicolson, tacksman of Colb, has been perfectly successful in raising grass from the seed. I should be glad to hear of some of the seed being sown in the salt-water marshes near Southampton, Dungeness, Isle of Sheppey, the fens near the Wash in Lincolnshire, the banks of the Thames, and south shore of Essex round to Harwich—in short, anywhere near the sea, preferring, as a general rule, marsh and peat-bogs to sand-hills or downs, al-

though I would always try both. I should also be glad to hear of some having been tried on inland bogs, as the bog of Allen and "Chatmoss." I have forgot to mention that I would sow the seed very early in the spring, and not too deep. I need not say that it will be a source of pride to me to be of any service to your Lordship, either in procuring seed or affording information at any time.

With great respect, I have the honour to be

Your Lordship's most obedient servant,

(Signed) R. C. Moody.

Government House, Port William, Falkland Islands,
8th January, 1846.

[From the *Irish Farmers' Journal*, May 20, 1846.]

The Tussac grass in its early stage requires gentle treatment, otherwise the young plants will fail after they have vegetated; and during the first year they appear delicate and uncertain: at least such is the result of my observations. I do not mean, however, to infer that the plant will not prove sufficiently hardy for our climate; on the contrary, I think it abundantly so: but more than one half of the plants raised here became sickly and dwindled away, without any apparent cause I could perceive, after they were planted out last May. Considering this occurred from their being deprived of saline matter, I had a very weak solution of common salt in water tried on two plants, leaving the others as they were. This solution was kept fully six inches from their roots, and did not appear to have any effect. The plants only commenced to grow freely towards the end of August, when they continued to make considerable progress until the middle of November. Being anxious to increase the stock as speedily as possible, and ignorant of the effect our winter would have upon them, I had the strongest plants taken up, divided, and replanted in a glazed frame, where only one out of the eight survived the winter. Three others were lifted with balls of earth, and potted without being disturbed. They continued to grow during the winter, and so did one good plant which was left without any protection in the open border, and which is now the best we have. It is growing vigorously, and will afford good side-shoots for propagating. These grow readily, if carefully slipped off, and planted in small pots at this period of the year. I have, therefore, no longer any doubt of the Tussac grass being freely introduced within a short period. From one good plant perhaps forty may be propagated in one season, if taken early in the year, as the offsets soon become strong, and afford young plants in their turns; neither have I any reason to doubt its suitableness for inland situations. Mr. George, gardener at Clonbrenny, county Meath—who, for intelligence and knowledge of his profession, is surpassed by very few in his line—informs me that the single plant he raised is now growing most vigorously, and producing plenty of young shoots. He further states that he is cultivating it in well-manured, rich, loamy soil, mixed with sand. The strongest plant we have is growing in peat and sand, where

it was weak until I had it well supplied with liquid manure, which it appears to relish, from the great progress it has made within the last four weeks. The leaves are now fully a foot long, and nearly half an inch broad. The indigenous grass to which the Tussac grass bears the greatest resemblance is the cock's-foot (Dactylis glomerata), both in the foliage and manner of growing in tufts. I allude to the young plants as they now appear, which of course will alter very considerably as they advance towards perfection. D. Moore.

Royal Dublin Society's Botanic Garden, Glasnevin.

V.—*Observations on the Natural History and Economy of various Insects affecting the Corn-crops in the Field and Granary, including Moths, Weevils and other Beetles, &c.* By John Curtis, F.L.S., Corresponding Member of the Imperial and Royal Georgofili Society of Florence; of the Academy of Natural Sciences of Philadelphia; &c.

Paper XI.

Before I take up the history of the insects that infest housed corn, it will be necessary to record a few species that attack the standing crops, which have not at present been noticed, and this I will do as briefly as possible.

Scopula frumentalis and P. Secalis—The Corn Pyralides.

The first moth is a native of Sweden and other parts of Europe, where it inhabits wheat-fields in June. It was named

1. Pyralis frumentalis by Linnæus, but it is now incorporated with a section of that group, called *Scopula*. It expands about an inch: the palpi are minute, the horns very slender, the eyes prominent; the thorax is moderately stout, as well as the abdomen; "the superior wings are shining, pale ashy green above, with two or three oblique whitish bands, with linked oval spots; the posterior margin is ciliated with alternate white lines; under side of wings greyish green." *

Linnæus and Rolandi † also describe an allied species called

2. Pyralis Secalis, which lives in the caterpillar state in the stems of rye, eating within the sheath, and migrating from one to another, rendering the ears white and empty. This moth, which I have captured the end of May and the end of June in the south of France, has grey-brown striate wings, with a kidney-shaped spot inscribed with a Roman A. ‡ Dr. Turton says the

* Linnæus's Faun. Suec., No. 1351. † Act. Stock. for 1752, p. 62.
‡ Linnæus's Syst. Nat., vol. ii. p. 882, No. 338.

larva is green, with three brown lines, and a reddish head, which is very similar to one I shall immediately describe. I wish, however, to state that I have examined the cabinet of the Linnæan Society, and find that a specimen of the *P. Secalis,* with Linnæus's autograph label attached, is identical with the species figured by Duponchel as the *P. frumentalis* above described, but of which I could find no specimen in Linnæus's cabinet. Treitschke and Duponchel affirm that Hübner's figure of *P. repandalis* is the female of *S. frumentalis*.

These moths are not at present recognised as natives of this country, but I think it probable that ere long they will make their appearance;—for the beginning of last March I received from Alton in Hampshire some wheat-plants; the blades looked sickly, and in the heart were larvæ of the *Oscinis vastator,** and of a caterpillar of some moth answering to Turton's description; but until I rear the moths I cannot determine upon the species. My correspondent T. C. stated that a large portion of the field was patchy, and affected by these larvæ, yet in putting them into a garden-pot with a wheat-plant they did not appear to feed. On the 8th of April, however, Mr. F. J. Graham of Cranford showed me some plants of wheat attacked by rust, and in one of the centre shoots was a caterpillar of the same species as the one from Alton. It lay with its head downward, and was about 8 lines or nearly two-thirds of an inch long, about the thickness of a small crow-quill, of a pale green colour, with a rusty brown head, and 2 narrow stripes of the same tint down the back; it was furnished with 6 pectoral, 8 abdominal, and 2 anal feet. I shall anxiously await the appearance of the moth, and I regret that the limits of this report will not allow me to give figures of the above insects.

It appears that these caterpillars are attended by a parasite, the *Ichneumon Secalis,* which lays its eggs in them. "It is the size of a louse," says Linnæus, "with a red head and beautifully green eyes; the thorax is entirely black, as well as the horns, which are filiform, but scarcely so long as the body; wings with a subrotund black marginal dot; abdomen ovate, black, smooth; petiole rough; aculeus as long as the body."† Fabricius describes this little fly as a Diplolepis,‡ but to which genus of the Chalcidites it belongs I cannot determine.

LEUCANIA OBSOLETA—The antiquated Leucania.

Hübner § figures this moth, which is one of the *Noctuidæ,* under

* Journal of Royal Agric. Soc., vol. v. p. 493, and pl. L. figs. 31 to 34.

† Linnæus's Faun. Suec., No. 1641.

‡ Fabricius's Syst. Piez., p. 152, No. 19.

§ Europ. Schmet. Noctuæ II., Genuinæ S, pl. 48, f. 233.

the above name. It was considered until recently an exceedingly rare insect in England, and we are indebted to Mr. Samuel Stevens for a knowledge of its economy. He was so obliging as to send me several of the caterpillars the third week in August, 1844. They generally undergo their transformations in fenny places amongst reeds, the leaves of which they eat; but having placed them in a cage with some fine oats coming into ear, I found they fed freely upon the leaves, notching the sides, and it is therefore desirable to notice the fact and to record their habits. These caterpillars, like many others, only come out at night to feed; and although full grown by the end of August, they remain in the shortened stems of the reeds through the winter, and the moths emerge from the pupæ during the entire month of June. When the caterpillars have arrived at their greatest size, they are often $1\frac{1}{2}$ inch long; they are linear, not quite semicylindrical, smooth, of a flesh colour, the edges of the segments being of the deepest tint, and clouded with dull pale green: the head is pale brown, reticulated with deep brown, having two curved lines down the face, of the same colour; the first thoracic segment is short and shining, with 3 whitish longitudinal lines which extend to the tail, and are edged with pale green; the 6 pectoral, 8 abdominal, and 2 anal feet are pale dirty green; the spiracles are pitchy, with a light centre; the head and tail are slightly hairy. When disturbed they curl up and fall down, but can walk very nimbly. When prepared to change to chrysalides in the spring, they leave the reed stubble, conceal themselves just beneath the surface of the earth, or draw together a few dead leaves or rubbish with a loose web to enclose the pupa, which is brown.

3. Leucania obsoleta is of a satiny texture: the female is of a dull pale ochreous colour; the antennæ are bristle-shaped; the feelers form 2 short beaks; the eyes are brown when dead; the tongue is spiral, and about as long as the antennæ; the superior wings are freckled with black; the nervures appear whitish, and are margined with brown; between them are brown streaks terminating in a black point at the base of the fringe, and there is a curved line of brown dots beyond the centre; base of abdomen and inferior wings nearly white; the latter, with the nervures and the exterior margin, smoky, with a line of black dots along the base of the fringe; expanse of wings $1\frac{1}{2}$ inch. The male is smaller, and of a paler and clearer colour; the nervures are not so strongly marked, and there is a smoky streak from the base to the centre; the under wings are white, a little freckled and ochreous at the exterior margin; before the centre is a dark spot shining through from the under side, and beyond the middle is a line of 4 or 5 similar dots.

CRIOCERIS MELANOPA—The Oat Crioceris.

I have read of the gelatinous larva of a *Tenthredo** which causes the leaves of the barley to wither by feeding upon the upper surface, but have never met with it. I have, however, found a larva of a similar nature, which I expected would change to the *Tenthredo,* but to my great surprise it eventually produced a beetle; and as the economy of this species is unnoticed by authors, I will transcribe my notes. On the 18th and 20th June, 1842, I found on the leaves of some oats coming into ear in a field in the neighbourhood of Sherborne, Dorsetshire, some slug-like larvæ which had eaten the epidermis in longitudinal lines. A small one was brown, mottled with ochre; it was very glossy, but looked slimy like a little slug; the minute head was black, and it had 6 small black pectoral feet; it was ovate or pear-shaped, being slightly narrowed towards the head. A larger specimen was more ochreous, and after being immersed in water for 24 hours it became perfectly of that colour: it then appeared transversely striated and wrinkled, with minute warts behind the head, which was brown; along each side was an elevated line of little brown bristly points; and the 6 feet were brownish towards their tips.† These larvæ feed down the leaves sideways, gnawing with their little mandibles an even line between the striæ, either above or below the leaf, leaving only the membrane, which often dries and cracks, making a hole of greater or lesser extent. In other instances they had occasioned ochreous spots where they rested, and where their old skins had been cast off, as they increased in size. I placed one in a box with some bits of earth, amongst which it formed a spongy whitish cocoon, irregular in form externally; but as I was not stationary at the time, its economy was probably interfered with, and the cocoon may be more regularly formed under natural circumstances. On the 10th of August I had the satisfaction to find in the box a specimen of *Crioceris melanopa*, a pretty beetle which is not uncommon in corn-fields and on rushes from the middle of April to the end of September. It belongs to the Order COLEOPTERA, Family CRIOCERIDÆ, and the Genus CRIOCERIS. The species was named by Linnæus,—

4. Crioceris merdigera. It is shining; the head is dark greenish blue, minutely punctured with a deep groove at the base; the face is concave; the mouth is pitchy; the eyes are black and

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* This genus belongs to the same family as the *Athalia spinarum: vide* Royal Agric. Journal, vol. ii. p. 371.

† It now resembled, in form, the larva of the Asparagus beetle, *Crioceris Asparagi*, which belongs to the same genus; *vide* the Gardener's Chronicle, vol. v. p. 592. Another species, *C. merdigera*, produces the larvæ which infest and render the white lilies of our gardens offensive.

prominent: the antennæ are twice as long as the thorax, subclavate, black and pubescent, excepting the basal joint, which is green, shining, and globose; 2nd small, 3rd and 4th obovate; the following compressed, broader, and obovate-truncate; apical joint conical: the thorax is reddish orange, often with 2 dusky spots on the disc; it is a trifle broader than the head, of an orbicular form, but the anterior angles are visible, and the base is contracted: scutellum blue: elytra elliptical, thrice as long as the thorax, and twice as broad, of a beautiful deep blue, sometimes with a slight greenish tint, and rarely black; there are 10 lines of long punctures on each: the wings are ample; the under side is deep blue and punctured: the 6 legs are bright and deep ochreous: the trochanters black: the thighs are stout: the tips of the tibiæ are dusky, and the tarsi are black and pubescent; they are 4-jointed, and cushioned beneath; the 2 basal joints are elongated, 3rd bilobed, 4th the longest, slender, clavate, and furnished with 2 simple claws: length 2 lines, breadth $\frac{3}{4}$. For figures and dissections of the *Crioceris* consult the 'British Entomology,' pl. 323; and in the 'Gardener's Chronicle,' previously referred to, the eggs, larvæ, &c. of *C. Asparagi* are figured and described.

I have already given the history and drawings of the metamorphoses of a caterpillar * which feeds on the wheat when in ear, as well as after it is stacked or housed; and in October last I received from Mr. Graham of Cranford another caterpillar belonging to the family *Noctuidæ*, of somewhat similar habits. Mr. Graham sent me about a dozen of them from the refuse wheat in his barn after thrashing. They were nearly $\frac{3}{4}$ of an inch long, and several of them died from injuries they had received. I put them into a box with wheat and chaff, and they evidently fed upon the grain during the winter, and increased in size very materially, one being at the end of February an inch long, and as thick as an oat-straw. They were exceedingly active, and disliked the light, generally burying themselves amongst the corn as soon as the box was opened; and in turning round they doubled themselves very much, so as to form a loop, the head approaching the tail. They were semi-cylindrical, with 6 pectoral, 8 abdominal, and 2 anal feet, of a dull ochreous red tint, and slightly hairy: there was an indistinct paler line down the anterior portion of the back, but it vanished behind, and each segment bore a V-shaped figure; the sides were darker, with apparently a pale oblique line on each segment, owing more to the light falling on the raised muscles than to colour, and the spiracle beneath each

* *Caradrina Cubicularis*, Journal of the Royal Agric. Soc., vol. v. p. 481, pl. K, f. 16-18.

was black: the head is rather small and shining: the centre of the eyes is dark brown: the antennæ are distinct, the tips dark: all the legs are pale, dark at the apex, the hinder pair spreading, and with the rump are ochreous, having a greenish tint, and this last segment has a darkish dilated line down the back: the under side is also of a dull pale greenish colour. Two of these caterpillars spun loose webs, to which some of the grains and chaff were attached; but they have not changed to pupæ, and I fear they are dead. Having, however, made a drawing of the caterpillar, I hope at some future time to ascertain the moth it ought to change to.

Having now given the agriculturist an idea of the insects with which he has to contend in the field, I wish to turn his attention, as well as that of all persons engaged in the corn-trade, to the various species which are destined to live upon the grain after it is stored away in barns and granaries; and if they were not principally confined to the latter, it would be a great inducement for stacking the corn. The ravages, however, made by these insects, may be justly attributed, I expect, in the first instance, to the importation of foreign corn; and, secondly, to the same storehouses being employed for many successive years without any purification or attempt at cleanliness. We well know if our own dwellings be neglected, if the rooms are not aired, and the broom and brush be not frequently employed, that a house soon becomes a harbour for moths, beetles, spiders, earwigs, woodlice, and hosts of various insects, which destroy our clothes and furniture, and soon render the rooms untidy. If such be the case in a neglected house, what can be expected in a large apartment shut up for months together, filled with articles on which numerous insects feed, under a regular and comparatively high temperature, badly ventilated, and where the walls and roof are never purified by whitewashing, or the floor ever scrubbed with hot water? If it were desirable to breed the corn-destroying insects, more certain means could not be adopted than the practice too often resorted to of storing grain and malt; for as sure as the soil will produce nothing but weeds if crops be not sown, so sure will almost all seeds become the prey of insects if they be neglected, and are not appropriated in due time either to reproduce their kind or to be converted into food.

A very great evil results from storing foreign corn, for owing to the regular and high temperature on the continent of Europe, especially in the southern states, insects generate with more certainty and in greater multitudes, and there is a larger number of species than in northern latitudes. In England there is not half the care required to preserve clothes, furs, collections of stuffed animals, insects, plants, &c., that there is in the south of France

even, and no doubt the same rule applies to agricultural produce; and it is this additional tax laid upon the inhabitants of warmer latitudes which has led to the general study of entomology, and to a high value being set upon scientific acquirements even by their legislatures.* By importing foreign corn we also import foreign insects; and as they are not generally exposed to the changes of the climate when the corn is stored, especially in large masses, they live and multiply until an unusually severe winter or other casualties destroy them. It is very probable that some species may not be able to live for a single season in our climate, however sheltered they may be, but others no doubt soon become naturalised.

I have also long entertained an opinion that epidemics, vegetable blights as they are termed, and noxious as well as other insects, gradually progress from the south-east, taking a direction more or less to the west or north, until they meet with so severe a check from temperature, that they gradually decline in virulence and power, and eventually become extinct for a lesser or greater period. This is certainly the case with some insects,† and the first species that falls under our notice seems to be gradually travelling northward. It has not at present, I believe, made its appearance in this country, and it will be fortunate for us if it never does.

BUTALIS CEREALELLA—The little Corn moth.

The little moth I allude to, whose scientific name is *Butalis cerealella*,‡ is called by the French "L'Alucita," or "Teigne des blés," or "Teigne des graines." It was first described by Réaumur; and from the ravages it has committed, its course has been noticed with intense interest by French agriculturists up to

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* In France, Germany, and Belgium, local laws are from time to time enacted to enforce the destruction of insects; commissions have been appointed to consider the best means of arresting evils arising from insect agency: distinguished men have been deputed by the governments to visit districts suffering from the incursions of insects, and to report thereupon, and the publication of the most costly illustrated works has been the result. In many cases efficient plans have been devised for arresting the existing mischief, and in all cases the first step towards effecting any good has been secured, by the attainment of an accurate knowledge of the economy of the noxious insects. I beg to refer the reader for further information to Kirby and Spence's Introd. to Entom., vol. i. p. 171 and p. 40, 6th ed.

† The locust, for instance, which occasionally reaches our shores from the south of Russia: Sphinx Nerii, Curtis's Brit. Ent., fol. and pl. 626; the cockroach (Blatta Orientalis); and numerous insects which exist in collections, and have not been seen alive in this country for many years.

‡ *Alucita cerealella*, Oliv., Encyc. Méthod., vol. i. p. 121; *Œcophora granella*, Lat.; *Tinea Hordei*, Kirby and Spence's Introd., vol. i. p. 174.

the present day. Dr. Herpin* says, "I have more grounds than ever to fear that the *Alucita,* which had somewhat disappeared during several years from our central districts, will show itself again in 1843 or 1844. I moreover fear that this scourge, which advances slowly from the south or west towards the north, will ere long penetrate into the fertile fields and the immense magazines of the Beauce. There will then no longer be time to avoid the most frightful disasters—famine and epidemics, which the Alucita brings after it. Imported into the Charente-Inférieure and Angoumois towards 1750, the *Alucita* was then propagated in the Aunis and Saintonge. About 1780 it commenced to spread itself in the Limousin; in 1807 it penetrated into the department of the Indre; in 1826 it invaded the department of Cher; it is now at the confines of the Beauce." † One may readily comprehend the dread expressed by our continental neighbours at the approach of this insect, when we learn from them that the infested corn loses 40 per cent. of its weight in 6 months, and 75 per cent. of the farinaceous substance it contains.

The following history of this moth has been principally obtained from Réaumur.‡ It belongs to the Order LEPIDOPTERA, Family TINEIDÆ, and the Genus BUTALIS of Ochsenheimer, according to Duponchel; but it agrees better, I think, with my Genus LAVERNA.§ The caterpillars live in the grain of different corn, as wheat, oats, and maize, but principally in barleycorns. The female moth lays a cluster of 20 or 30 eggs upon a single grain, in lines or little oblong masses in the longitudinal channel; and this operation is performed in the field before the ears are perfectly matured, as well as in the granary: they are of a beautiful red orange colour. The caterpillars hatch in 6 or 7 days after the eggs are laid, and sometimes in 4 only, and then they are hardly as thick as a hair. The first caterpillar which hatches penetrates into the grain, in a little spot between the beard and the appendage of the sheath, which is more tender than the rest; but the aperture is imperceptible owing to the minuteness of the larva. Having taken possession of the grain, the remainder, as they escape from the shell, have to seek other grains; and when they find them unoccupied they pierce and enter them in the same way as we have described, so that each grain contains no more than one occupant; and this is sufficient to support the larva until it arrives at ma-

* Recherches sur la Destruction de l'Alucite, ou Teigne des Graines: published in Paris, in 1838.

† Mémoire sur divers Insectes nuisibles à l'Agriculture, par J. Ch. Herpin.

‡ Mémoires pour servir à l'Hist. des Insectes, vol. ii. p. 486, pl. 39, figs. 9-19.

§ Curtis's Brit. Ent., fol. and pl. 735.

turity, when it changes to a pupa within the grain, which is entirely emptied of farina, yet still to the eye it appears a sound grain. If, however, it be taken between the fingers and pressed, it is found to be soft; and an experienced person can discover whether the grain contains a young larva or a pupa. By washing the corn the injured grain is readily detected.

This little caterpillar is very smooth and quite white; its head only is a little brown: it has 16 legs, of which the 8 intermediate and membranous ones are only like little buttons, and so minute that one cannot perceive them without a strong magnifying-glass; and by the same means the ends of these legs appear to be bordered with a complete coronet of brown hooks. It is but little more than 3 lines long.

A grain of wheat or of barley contains the exact quantity of nutrition necessary to feed and support this caterpillar from its birth until its transformation. If a grain containing a caterpillar be opened when it is near to its metamorphosis, one sees that there is nothing more than the skin remaining: all the farinaceous substance has been eaten. The cavity contains, besides the larva, some little brown or yellow grains, which are its excrement; and as these are found to be less in bulk and number with the old than with the young caterpillars, it is concluded that they eat these deposits once or twice, as there is no aperture by which the excrement can be expelled. Having consumed all the flour in the grain, the caterpillar spins a white silken cocoon which lines the inside of it, or rather a portion; for the grain being divided longitudinally, and in two unequal parts, the smaller compartment is reserved for the excrement, which is pushed on one side.

Towards the end of November there are many caterpillars in the grains, and in spring almost always only pupæ. Some eggs must hatch much earlier than others, from the clusters which are deposited at the same time. The moths first make their appearance in some years the commencement of May, in others in June, and again in November; but these live only 2 or 3 weeks at most. The moth makes its escape through a little round hole in the side of the grain, which the caterpillar cuts with its mandibles without displacing the stopper, before it spins its cocoon.

5. Butalis cerealella expands rather more than 1 inch: the head is smooth: the antennæ are setaceous, but appear a little beaded when magnified; the feelers are long, curved, and elevated; the basal joint is clothed with scales, and shorter than the 2nd, which is pointed: the proboscis is long, and very visible: the head, body, horns, palpi, and legs are of a light grey or coffee-and-milk colour: the superior wings are of the same colour above, with some faint blackish atoms at their extremity;

they are straight, with the apex very pointed when deprived of the fringe; they form a rounded or depressed roof in repose, their extremities crossing one another: the fringe, which is of a clearer colour, is also sprinkled with similar atoms along the internal margin: the under side of these wings is of a rosy shining brown: both surfaces of the inferior wings, including the fringe, are of a leaden grey.*

Réaumur mentions a parasitic fly which sometimes hatches from the grains containing the caterpillars or pupæ, to the number of 20 from one insect; and Olivier says, "One thing worthy of remark is that the moths which hatch in the month of May from the grains shut up in the granaries, hasten to get out by the windows and to gain the fields, instead of which those that come forth immediately after the harvest make no attempt to escape. It seems that their instinct informs them that they will then find no more provision in the fields for the support of their posterity."†

The foregoing account will enable those interested, more readily to detect the presence of the Little Corn-moth, and the following remedies may be equally useful, if applied to other grain-feeding insects, even should we be spared from the visitations of the *Butalis*, which seems to have made its appearance in the United States of America, from specimens sent to Mr. E. Doubleday by Dr. Harris of Cambridge, New England. It may be as well to state, that the example I have carefully examined has black fore-legs, and a black spot near the tip of the palpi, characters which I do not find recorded by the French naturalists.

It appears that of the various attempts made to prevent or diminish the ravages of this moth, the most effective method is to subject the infested grain to the heat of an oven or a very warm room. It does not seem to be ascertained what degree of heat the grain can endure without losing its germinating powers, but it appears that it is preserved at above 70° Réaumur (about 190° Fahrenheit). It is not, however, so much the intensity of the heat, as its continued action for a certain period, which kills the caterpillars and chrysalides in the grain, so that from 45° to 50° during 24 or 36 hours produce more effect than 76° or 96° for one hour. The difficulty is to maintain an equal temperature throughout the operation, and to obviate this, two machines have been invented and called "Insect mills." One, by M. Marcellin Cadet de Vaux, is a kind of large iron cylinder for roasting (bruloir), as simple as the common ones for coffee; the other, by

* Having no authentic specimen to describe, I have given the characters from Reaumur and Duponchel.

† Encyclopédie Méthodique, vol. i. p. 115.

M. Terrasse Dubillon, is also a kind of roaster, but with many spiral concentrics into which the grains successively pass.*

"The grain being put into the roaster the instrument is turned over the fire like the coffee-roaster for 5 minutes; the grain is then withdrawn, the temperature being 57° Réaumur, and that must be calculated at about 60°, through the loss of heat which it experiences from opening the door and introducing the thermometer. The experiments made by the commission named by the Agricultural Society of Cher (in France) with this machine, proved that all the larvæ contained in the grains were dead and dried in the prescribed time (50 minutes); that these grains, afterwards placed by the side of those infested, have undergone no more fermentation, and have been no more devoured by insects; that they have suffered no more waste than the others continued to suffer; finally, that the entire grains which had been put into the roaster, have germinated as well as the other grains which had not been placed there.

"The commission of Cher has verified that the machine of M. Marcellin was thus able to prepare, in one day, 120 common bushels (boisseaux †); that a man and woman, or two women only, were sufficient to work it; and that with the fuel employed the expense in the country amounted to 3 francs per diem, or to a demi-sou (less than a farthing) per bushel.

"The machine of M. Dubillon has produced the same results as M. Marcellin's, with a little more saving in labour. From the entry of the grain to its exit from the mill it passes over 300 feet, and the first grain introduced has taken 4½ minutes to traverse this space: 14 boisseaux have passed through in 1 hour, which gives 140 boisseaux in 10 hours of work, or 20 boisseaux more than M. Marcellin's roaster. The consumption of fuel was not greater, and two persons equally sufficed to serve the machine, it consequently shows that the expense is a little less; but it must be observed that M. Marcellin's roaster is much more simple and cheaper than the complicated one of M. Dubillon, and is better suited to the pocket of the small cultivator than this last."

Simple friction promises to answer every purpose, as will appear from the following remarks made by Dr. Herpin: ‡—"I think I have made a discovery of a very easy and very economical process for destroying the Alucita (*Butalis cerealella*) in its different states. It is by means of an Agitator or Shaking-machine, similar to the vertical Tarares, furnished with little wooden or

* The foregoing and following facts have been copied from Duponchel's Supplement to the Lepidoptères de France, vol. iv. p. 444.

† A boisseau is rather more than an English peck; thus, 3 boisseaux are equal to 1 English bushel, and 107 parts of a thousand over.

‡ Recherches sur la Destruction de l'Alucite, ou Teigne des Graines.

iron wings, propelled with very great velocity (600 revolutions a minute). The shakings and concussions which the corn receives in passing in this machine are so multiplied and so quick, that the eggs are broken or detached from the corn; the insect is mauled and killed even in the interior of the grain where it is enclosed. I have not been able to make this experiment on a large scale, because I have not had a sufficient quantity of infested corn; but I have observed that some corn containing living larvæ of the *Alucita*, shaken briskly by the hand in a glass bottle for an hour, has produced only a small number of the moths, compared with that which came out of the same corn which had not been submitted to this agitation. I have thought it my duty to record this fact, and to publish it."

TINEA GRANELLA—The Wolf, or little Grain-moth.

A moth, in some respects similar to the "Little Corn-moth" in its habits of life, is completely established in this country, as well as in every part of Europe. It is called in English works "The mottled woollen moth,"* and it has received the scientific appellation of *Tinea granella*. The caterpillars do incredible mischief to bonded and housed corn laid up in granaries, and they are, I believe, called "White Corn-worms." From April till August the little moth is found in granaries and magazines, resting by day on the walls and beams, and flying about only at night, unless disturbed. Soon after they have escaped from the chrysalis the sexes pair, and the female lays one or two eggs on each grain of corn until she has deposited thirty or more:† they are so minute that they can only be detected by a good magnifying glass, when they appear of an oval form and of a yellowish-white colour.

The small white worms hatch in a few days (sometimes it is 16), and immediately penetrate the grain, carefully closing up the aperture with their roundish white excrement, which is held together by a fine web (pl. P, fig. 1). When a single grain is not sufficient for its nourishment, the larva unites a second grain to the first by the same web, and thus it ultimately adds together a great number (fig. 2), forming a secure habitation, which at the same time is well stored with provisions. When the maggots are almost full grown, they often leave their lodgings in great numbers, running over the corn and covering the whole surface so effectually, with a thick web of a greyish-white colour, sometimes forming a crust 3 inches thick, that scarcely a grain of corn is

* Haworth's Lepidoptera Britannica, p. 563.
† Leuwenhoek says they lay from 50 to 70 eggs. Phil. Trans., vol. xviii. p. 194.

visible. It is considered that the object of this operation is to protect themselves from their enemies, as well as from transitions of the temperature. At this time the caterpillars are about 5 lines long (fig. 3), of a pale ochreous colour, composed of 13 segments, with 6 pectoral, 8 abdominal, and 2 anal feet: the head is horny, shining, and red-brown, and there are 4 dark transverse marks on the first thoracic segment, being two sections of a circle broken in the middle (fig. 4, magnified). It is in August or September that the caterpillars have arrived at maturity, when they leave the corn-heaps and search for a safe and suitable place to undergo their metamorphosis, and at this period they are usually most observed. They form their cocoons (fig. 5) by gnawing the wood, and working it up with their web, in any chink in the floor, walls, or roof, which are frequently swarming with them, and these cocoons being the form and size of a grain of corn look like one dusted over. It there remains in its snug and warm berth, in the larva state, through the winter, and does not change to a chrysalis until the month of March following, and in a backward spring not until May. The pupa (fig. 6) is of a deep chestnut colour, the abdominal rings being of a shining yellow tint, and the apex is furnished with two little points (fig. 7, the same magnified). In two or three weeks after they have assumed the pupa form the moth hatches, with almost perfect wings at its birth, I have heard, leaving the empty chrysalis sticking half out of the cocoon (fig. 8).

This moth (fig. 9) belongs to the Order Lepidoptera; Fam. Tineidæ; the Genus Tinea, and bears the Linnæan name of—

6. Tinea granella. It is of a cream-white with a satiny lustre: the head hairy and tufted, concealing the eyes from above; these are hemispherical and slate-coloured: antennæ rather shorter than the body, setaceous, composed of innumerable subquadrate joints, pubescent, and clothed with depressed scales: tongue or spiral proboscis very short and scaly outside: maxillary palpi articulated, but very minute;* labial palpi long, scaly, drooping, divaricating, and triarticulate, 2nd joint the longest and stoutest, 3rd more slender, elliptic-conical: thorax clothed with scales: abdomen linear and blunt at the tip in the male, in which sex the organ of generation is sometimes exserted like a fine long sting; the apex is conical in the female, with a telescopiform ovipositor: wings very much deflexed or sloping, like the roof of a house, with the fringe curved up in repose (fig. 9); superior longish and lanceolate, with many deep rich brown irregular spots,

* It appears to me that these organs are most fully developed in the females.

freckled between; there are 6 on the costa, the 3 nearest the base are the largest, the 3rd semilunate, the 2 following minute, and on the inner margin is a brown oblong spot, forming an acute angle with the 3rd; the fringe is long and brown, with pale stripes: inferior wings smaller, lanceolate, of a pale mouse colour, coppery towards the tips; the fringe very long and fine: 6 legs; hinder thighs very short; anterior shanks short, with a hairy spine on the inside, the others spurred at the apex; the posterior long, clothed externally with long hairs, having a 2nd pair of long spurs near the base; tarsi longer than the tibiæ, slender, tapering, and 5-jointed; claws very minute: expanse of wings 5½ lines (fig. 10, greatly magnified). The female is larger and darker. I cannot describe the trophi or organs of the mouth with the accuracy to be desired, owing to my not being able to obtain living specimens of the moth; but dissections of an allied species, very destructive to clothes, have been figured and described in the 'British Entomology,' pl. 511.

It is difficult to guard against the introduction of this moth, since it deposits its eggs on the sheaves in the field, as well as after the grain is stored and threshed out, and it will feed as freely upon barley, rye, and oats as upon wheat; and Leuwenhoek adds, "That these worms are not only destructive to corn, but are also in old timber, books, boxes, woollen stuffs, and the like." In reflecting upon the economy of this destructive insect, it is not difficult to suggest palliatives, if not remedies, and it appears to me that if the following rules were strictly attended to, few persons would suffer from the inroads of this insect:—

1st. Before replenishing an empty granary or loft, the floor should be well scoured with hot water and soft-soap, or lees if practicable, if not it must be well brushed with a fine stiff broom, to clean out the chinks or fissures between the boards. The roof and beams should be whitewashed, as well as the walls, with lime-water, used as hot as possible; and these operations would have greater effect if performed in the winter months. I presume coal-tar would be even better, if the scent be not communicated to the grain. Sprinkling the floor with salt dissolved in strong vinegar has been recommended, and might be very serviceable.

2ndly. In granaries already stored, where the caterpillars are at work, whatever method for their destruction may be resorted to, by heat, ventilation, or otherwise, it must be employed during the summer, from the end of May to the end of August; occasionally a month earlier or later, as during the winter these larvæ are not to be found amongst the corn-heaps; they retire in the autumn, to conceal themselves in fissures and cracks in the floors and walls, and form their cocoons.

3rdly. The moths themselves might be destroyed in April and May, when they deposit their eggs, by burning a very powerful light, even in the daytime in dark granaries; for being attracted by the brightness of the flame, they would fly into it and be destroyed, or fall down sufficiently injured to prevent their doing any further mischief,* and at the same time the corn ought to be frequently turned over with shovels, to kill the eggs and disturb the young larvæ.

To complete the work, all cracks and broken places in the walls and roof must be stopped with Roman cement or plaster of Paris, to prevent the ingress of the moth, and the apertures left for light or ventilation must be covered with wire gauze. It is a great mistake to leave the inside walls and roof in a rough state, as they afford exactly the retreats fit for the transformations of the larvæ: it would therefore be very advisable to have them smoothly plastered.

When the larvæ are securely feeding in the grain, one of the best remedies is to subject the whole to a sufficient degree of heat to destroy the insects. This is said to be best effected by kiln-drying, as a temperature of 19° of Réaumur (about 78° Fahr.) will kill the larvæ; but it can only be applied to corn intended for the mill, as it destroys the vital principle so that it will not germinate.† The great object in this process is to obtain the required heat as speedily as possible, and to let the vapour escape through apertures made for the purpose, in order that no unpleasant odour may be communicated to the corn.

Having so far shown what may be accomplished by heat, I wish now to turn the reader's attention to what has been proposed to be effected by an opposite process, which may be termed the Cooling system. It being ascertained that the larvæ of the corn-moth cannot live in a lower temperature than 12° or 10° of Réaumur—namely, under a temperate heat—that they become torpid in a temperature of 6° or only 8° *above* zero, and that they die if this low state be maintained for any length of time, Dr. Hammerschmidt‡ has proved by repeated experiments, that by keeping up

* A contributor to the Gardener's Chronicle says, "Would not a few gas-lights kept burning in the granaries, during the months the perfect insect is on the wing, prove both attractive and destructive of this pest? Lamps would not do, as they would soon be extinguished by the dead moths."—vol. i. p. 133.

† Such is Kollar's statement in his Natur der Schœd. Insecten, p. 128, but surely it must be incorrect, as the French assert that 60 degrees of Reaumur will not injure the germination of the corn, and it is liable to a much higher temperature than 19 degrees in the open field.

‡ Kollar, p 128. I may here acknowledge my obligations to this useful work, and the translation, for many of the foregoing observations relative to the *Tinea granella*.

an artificial cold atmosphere by means of ventilators, a sure remedy is effected. This is easily done by making small windows in all directions, near the floors of the storehouses, which will supply the current of air required. If the tubes be introduced through the closed windows, one end being carried into the corn-heap, a draught will be created which will at once reduce the temperature sufficiently to attain the desired object; or the tubes may be laid in the floor with the end rising a foot above it, and covered at the top with a perforated rose, like that of a watering-pot: over these the corn must be thrown, to receive the cooled draught thus created.

Fumigation has been also recommended by M. Granier, who explained his method of preserving corn for long periods before the Academy of Sciences at Paris. "The corn was well winnowed, and put into a vessel or room perfectly free from damp; the external air was excluded, and then sulphuric acid was introduced by means of burning sulphur within, as is done in this country for whitening peeled wicker-wares. If many insects should be found to be destroyed by this method, pulverised charcoal should be mixed with the corn, to obviate the effects of putrefaction. M. Garnier had kept corn six years perfectly good by a renewal of this operation once a year."* It is, however, positively stated that fumigation with brimstone has been found of no use, as it only induces the larvæ to bury themselves deeper in the corn-heaps.

Sprinkling the corn with common salt is considered very beneficial: indeed Roësel says that salt powdered and mixed with the corn will kill the larvæ, or it may be dissolved in water and sprinkled over it; and it will not in any way injure the corn, as brimstone, wormwood, &c., do, by communicating a disgusting flavour. When there is room, it is a simple and successful plan to form a small heap of a bushel or two of corn near the centre or the part most affected, and leave it undisturbed, whilst all the rest is to be turned over repeatedly, which will compel the larvæ to take refuge in the small undisturbed heap; and by pouring hot water over it, the insects can be readily destroyed: many will, no doubt, climb up the walls, but these can be swept off.

I must not omit to notice some interesting observations made in the 'Introduction to Entomology,'† showing the extent to which this moth is multiplied in our granaries, and the serious consequences that might arise from neglecting to take timely measures for its extirpation. It is true that the facts in some degree contravene the modes that have been recommended to expel this pest;

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* Literary Gazette, Aug. 1, 1840.

† By Kirby and Spence, vol. i. p. 140, 6th ed.

nevertheless, my advice to those who are sufferers is, to persevere It appears that in October, 1837, the extensive granaries of Messrs. Hellicar, in Bristol, the greater part of which had been built within the two previous years, were infested by these insects. Mr. Spence, who visited the premises with Mr. Raddon, says, "We found the barley lying on the floors covered with a gauze-like tissue, formed of the fine silken threads spun by the larvæ in traversing its surface, on recently quitting it for the purpose of undergoing their metamorphosis in the ceiling of the granary, formed of the joists and wooden floor of the story above. What was remarkable, as Mr. Raddon communicated to the Entomological Society,* was the great depth to which the larvæ had bored in the wood—even through knots filled with turpentine, so as to convert portions of the wood-work in places quite into a honeycomb, and thus to be almost as injurious to the building as to the corn stored in it." It is certainly very strange that these larvæ, after being glutted with the farina of the corn, should wander from the heaps to feed upon timber, even saturated with turpentine. Such, however, is the fact; and Mr. Spence adds, "that their main purpose (whether we suppose the excavated wood to be eaten and digested, or not)† is to provide a retreat for the larvæ, which remain in this state the whole winter, and do not become pupæ till spring, is proved by the fact that it is from the mouths of these holes (after every portion of the excrement hanging from them has been swept away, and the whole ceiling thickly lime-washed, as it is every autumn) that the moths emerge by thousands in the month of June, as yearly takes place in Messrs. Hellicar's granaries." Some of these caterpillars ate through paper into the cork where they were placed.

If diseased corn be used for seed, it is important to sow it deep, for the caterpillars will become pupæ in the earth; and it has been observed that when that practice has been adopted, few of the moths were able to struggle through the soil, and those were in a weak and languid state; whilst the corn which was buried about an inch only, with the larvæ in it, produced the moths, which readily made their escape from the chrysalides. It is also desirable to cut the corn in good season, and not suffer it to stand too long in the sheaf, as the moths will be enabled to lay their eggs in the ears in the field, and are thus introduced into the barn.

The natural enemies of the grain-moths are—bats, which feed upon these and other moths, especially those that surround and inhabit the same localities. Spiders also occupy the angles of the windows and doorways, spreading their nets to catch such prey.

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* *Vide* the Transactions, vol. ii. p. lxviii.

† *Vide* Leuwenhoek's statement in a preceding page.

The grey and yellow wagtails and many other small birds are insectivorous, and might be enticed to visit our barns and stack-yards by placing water conveniently for them; and, as Dr. Hammerschmidt observes, the excrement of the birds, which might easily be removed by winnowing, is not to be compared to the filth of the caterpillars for its injurious effects.

THE CORN-WEEVILS.

From the numerous statements and complaints that have been transmitted to me, I am inclined to believe that no insect does more mischief to stored corn, in England at least, than these weevils, of which there are two species; but neither of them are natives of this country, although one is perfectly naturalised. Probably the best plan will be to describe and figure these two species, then to relate their economy, and finally to investigate the remedies. These weevils belong to the Order COLEOPTERA, the Family CURCULIONIDÆ, the Genus CALANDRA,* and one species is called by Linnæus—

7. C. Oryzæ, the Rice-weevil (fig. 12; fig. 11, the natural size). It is smooth, elliptical, and somewhat depressed; some specimens are of a pale chestnut or ochraceous colour, others are the tint of pitch, with every shade between the two extremes, regulated possibly by the age of the insect; the head is semi-ovate, the base smooth, and capable of being withdrawn into the thorax; it is sparingly punctured; the eyes are not at all prominent, but black, granulated, elliptical, and vertical; the space between them has a deep V-shaped groove, with a smaller one on each side; the fore part of the head is elongated into a stout rostrum or beak, twice as long as the head, nearly cylindrical, straight, smooth, and sparingly punctured; it is a little dilated at the base, with 4 grooves or lines of punctures, especially in the males, in which sex it is the stoutest; at the tip is the mouth, which is very minute, but composed of 2 horny mandibles, serrated so as to form 4 large teeth (fig. *a*); the maxillæ are minute (fig. *b*), terminated by an oval lobe, with a slender triarticulate palpus on the outside (fig. *c*); the horns are as long as the rostrum, and inserted on each side of it, close to the base; they are 9-jointed (fig. *d*); the basal joint is very long, and forms an elbow with the remainder; the 2nd is subglobose, the 3rd obovate, the 4 following are short, more or less cup-shaped, the remainder forming a stouter ovate-conic club, the basal joint being by far the largest; the thorax is twice as broad as the head, oval, but truncated at the base, with the angles

* Schönherr, who supersedes established names, I think unnecessarily, has changed this to *Sitophilus*.

rounded; it is suddenly narrowed before, at the base of the head, and the whole surface is covered with large deep punctures, leaving a smooth line down the centre, but almost uniting on the sides; the scutellum is minute and semi-ovate; the elytra are about as long as the head and thorax, not broader, oval, but truncated at the base, and sometimes narrowed a little at the middle; the dark specimens have 4 distinct orange-coloured spots, 2 on the shoulders and 2 near the tips, and there are regular rows of confluent deep little pits down the back, with lines of minute bristles between the alternate rows; the wings are ample, and folded under the elytra; the under side is coarsely punctured; the 6 legs are very strong, and rather short; they are also punctured, especially the thighs, which are stout; the shanks are short, slightly compressed, with series of minute bristles down the outside, and a short curved claw at the external apex; the tarsi can be bent quite back against the shanks, and are 4-jointed; the 3rd joint is bilobed, the 4th clavate and furnished with 2 minute claws: it is only $1\frac{3}{4}$ line long, and scarcely $\frac{2}{3}$ broad.

I have often in early life found these beetles amongst rice, from which grain it receives its specific name *Oryzæ*, and it no doubt was originally imported from the East Indies with that important article of food; but I have seen it infesting wheat from Ancona, sent to Mark-lane for sale in 1844, and from various granaries. Professor Royle also transmitted me specimens which were destroying East Indian wheat in the ships by which it was brought over to this country.

On cutting open the grains of the Ancona wheat, I found at the base of the kernel, in multitudes of instances, a cavity (fig. 13) containing a very small larva, curled up, of a dirty-white colour, with a ferruginous horny head (fig. 14 *e*). This is the young grub of the weevil, and I have no doubt the egg is deposited by the female in this end of the grain, but I have never succeeded in obtaining the eggs or rearing the larvæ. I could not help remarking, that however sound the grains might appear outside in this sample, there were scarcely any that had not been perforated (fig. 15 *f*; and 16 *f*, the same magnified); and I could not find one in twenty that did not contain some of the beetles or grubs (fig. 17). The pupæ that I found *in sitû* were all dead, and consequently not such perfect objects as I wished to delineate (fig. 18; *g*, the natural size): they are, however, like most weevil pupæ, of a yellowish-white colour, and soft, with the rostrum, antennæ, legs, and elytra visible through the skin.

It is evident they are preyed upon by a parasitic hymenopterous insect, for in one of the grains I detected an apterous blackish-green specimen with rufous legs, but it was too much mutilated to draw from. I am pretty certain it is the same species, or closely

allied to one, named *Meraporus graminicola*,* which we often find in this country in July (fig. 19; *h*, the natural size).

The other species of corn-weevil alluded to received the name of *Curculio granarius* from Linnæus. It belongs to the same genus as the preceding beetle, and is now called—

8. Calandra granaria. The granary-weevil is a little longer, and more smooth and shining than *C. Oryzæ;* it is somewhat depressed, and varies in colour from a deep pitch to a dark chestnut tint; the head is semiglobose, produced anteriorly into a longish, smooth, cylindrical proboscis, which is shortest and stoutest in the male: it is slightly curved, and sparingly punctured, with 2 lines of punctures extending almost from the base of the head to the apex, forming two deep channels before the eyes, where the rostrum is dilated; on either side of these are one or two lines of punctures: the eyes are black, vertical, ovate, finely granulated, and depressed; the mouth, including the little strong jaws, maxillæ, and palpi, is placed at the extremity of the rostrum: the antennæ, which are as long as the rostrum, are inserted on the sides close to the base, they are nine-jointed; the basal joint is long, stout, and clavate; it forms an angle with the remainder, the second being subglobose, the third obovate, the four following more or less cup-shaped, the seventh being the largest, the residue forming an oval, conical, little shining club, pubescent at the tip: thorax twice as broad as the head, oval, a little truncated and suddenly narrowed before, with a transverse impression; greatly truncated at the base, which is bisinuated: the surface is coarsely, not closely, punctured with oval points; scutellum minute and oval; elytra exactly equal to the thorax and head, occasionally a trifle broader near the base, being ovate-truncate, and not covering the apex of the abdomen; there are 9 deep punctured channels down each, producing short pale bristles, and the 2 raised furrows on each side the suture have a line of long punctures; wings, none, or rudiments only: the under side is covered with exceedingly large punctures: the 6 legs are punctured, strong, and stout, especially the first and last pairs; the thighs are stout; the shanks are shorter and straight, the anterior are crenulated inside, and they all have a hook or claw at their extremities; the tarsi are reflexed and four-jointed, spongy beneath, basal joint subclavate, second ovate, third broader, slightly bilobed, fourth clavate, and furnished with two minute claws: length nearly 2 lines, breadth $\frac{2}{3}$ (fig. 20; and 21, greatly magnified).

It is remarkable that whilst *C. Oryzæ* has a pair of serviceable wings, *C. granaria* is destitute of the organs of flight, at least in

* Vide Curtis's Guide, Gen. 630 *f*.

this country.* I regret that I have no experience regarding the transformations of this species, for all my attempts to rear it have been unsuccessful. In June, 1844, I carefully examined some barley in a box, which I had procured the previous autumn; numbers of the weevils had hatched, and many were lying dead, but I could find neither eggs, larvæ, nor pupæ. Leuwenhoek and Olivier, however, will supply this deficiency; the former of these authors made many observations, which were published as long back as the year 1687, and the latter in the 'Encyclopédie Méthodique.' It has been ascertained that after the weevils had paired, the female made a hole in the grain of wheat with her rostrum and deposited an egg in it, from whence hatched a little maggot, which during its growth ate out the entire contents, and then changed to a pupa in the empty husk, and eventually the perfect beetle ate its way out. The maggot is nearly a line long, very white, soft, and elongated; the body is composed of projecting and rounded segments, and is furnished with a large, horny, round, yellow head, with teeth or jaws to nibble the substance of the grain. Only one maggot is found in each grain, as it is no more than is necessary to support it whilst it is in that state.† The pupa is a clear-white, and transparent, so that one can distinguish through the envelope the rostrum, antennæ, and the other members of the insect. In this state, of course, it takes no nourishment, but lies dormant, and only shows symptoms of life by moving its abdomen when it is disturbed. Eight or ten days after this metamorphosis the weevil bursts the filmy skin in which it is swathed, and pierces the epidermis of the grain to form an aperture and leave its prison. It is the maggots which make the greatest havoc amongst the corn, yet it is evident that the weevils also feed upon it, as they are sometimes found, of a dark colour, enclosed in the grains.

It is well known that a certain degree of heat is necessary to invigorate these weevils and induce them to copulate. If the temperature be under 8° or 9° (50° or 52° Fahr.) the sexes have not sufficient energy to search for one another; they live in a state of repose and even of torpor if it be cold, and are then incapable of mischief. On the return of spring, especially in countries where that season is sufficiently favourable to raise the temperature to 10° (54° Fahr.), the sexes pair; this happens about April in the south of France, and they go on propagating until the end of August: so that the destruction of grain is much more considerable in the southern than in the northern provinces.

* It is very probable that in warm latitudes these organs may be fully developed.

† Encyclopédie Méthodique, vol. v. p. 488.

The warmer it is the oftener they pair, consequently the female lays her eggs every month when the heat is sufficiently great, but as soon as the mornings begin to be cold she ceases to lay; and such is the vast multiplication of this insect sometimes in the granaries and magazines of France, that of a heap of corn, nothing but the husks is left, and all kinds of grain are acceptable to the Granary-weevil.

From the moment of pairing until the time when the weevil is hatched occupies about 40 or 45 days, from which it is evident that there are many generations in a year, which, as I have shown, multiply more rapidly in a hot country. From a very curious table, established upon the multiplication of the weevils, by adding together the number of each generation, the result obtained is a sum total of 6045 individuals proceeding from one pair only of weevils during a summer, namely, during five months, dated from the 15th of April to the 15th of September, when the thermometer is above 15° (nearly 66° Fahr.), and it never descends much lower in the southern provinces of France. As Olivier says, "One cannot be any longer astonished that enormous heaps of corn are sometimes so speedily devoured." As soon as the female weevil has been impregnated, she plunges deep into a heap of corn to lay and conceal her eggs immediately under the skin of the grains; she makes a puncture where it is slightly raised in this part, and forms a little elevation which is scarcely perceptible. These holes are not perpendicular to the surface of the grains, but oblique, or even parallel, and stopped with a kind of gluten the colour of the corn. The female never lays more than one egg in each grain, which is not long in hatching, and, when lodged in the grain, is perfectly secure from changes in the atmosphere, because the excrement that it makes seems to close the opening by which it entered, and even when the corn is removed it is not incommoded by any shaking it may undergo.

It will be observed that the weevils are not found on the surface, but some inches deep in the corn-heaps; it is there that they live, very often couple, and that the females lay their eggs. Moreover, on looking at a heap of corn, one cannot detect the operations of these insects in the grains where they are lodged; they have the same form, the same appearance, they seem to be as large, as firm as those which are not attacked: it is only by the weight that they can be detected, and on throwing a handful from a heap into water, the diseased grains will float. So long as the weather remains hot the weevils do not quit the corn-heaps they have invaded, unless they are obliged to abandon them by stirring the corn with shovels or passing it through a sieve. When the mornings begin to be cool, all the weevils, young and old, abandon the corn-heaps, which are no longer a retreat sufficiently

warm for them; they retire into the crevices of the walls, into the cracks in wood and planks; sometimes one even finds them concealed behind the hangings, indeed wherever they can find a safe abode that secures them from the cold, which makes them desert the granaries.

It is, however, wrong to suppose that the weevils remain in a torpid state during the whole of winter, to regain, on the return of spring, the corn-heaps which they have abandoned, and to commence laying eggs there. A general and constant rule amongst insects is, that those which have paired die soon afterwards, the males almost immediately, the females as soon as they have performed their office of laying the eggs, and that they pass the winter in the egg or larva state. It is undoubtedly seldom that those which have not fulfilled the destiny of nature can brave the rigour of the season, and do not perish before the ensuing spring. The weevils seem to love darkness and to remain undisturbed, since, when they are exposed to the daylight, they scamper off to conceal themselves. Such is Olivier's account.

There is one thing to be borne in mind regarding the corn-weevils, namely, that in this country, at least, they are never found in corn-fields, the eggs are consequently not laid until after the wheat or barley has been threshed out, and the *C. Oryzæ* requires a much higher temperature to invigorate it than the *C. granaria* does; it is therefore only under very favourable circumstances, such as an unusually hot summer and mild winter, or in granaries naturally warm from local circumstances, or in the close holds of ships, that this species can cause any alarm in our temperate climate. It is in the East and West Indies far otherwise, and even in the south of Europe, as we have seen by the wheat from Ancona. Mr. Sells, who had resided in some of the West India Islands, stated before the Entomological Society that "*C. Oryzæ* was exceedingly abundant in the stores there, destroying great quantities of Indian corn and rice, and, to prevent its attacks, it was necessary to expose the grain to the sun, and to winnow it frequently."*

It is the *C. granaria* which does incredible mischief to our stored corn, as may be collected from the remarks already made, and barley and malt suffer the most from their inroads. I put these beetles into a box with barley, maize, beans, peas, and wheat one autumn, and in the spring I found the barley was all eaten out, and a few grains of the maize were completely excavated; but the wheat, peas, and beans were untouched. On the other hand, in December, 1843, I received some *wheat* and black oats from Lynn, in Norfolk, in which the weevils abounded and

* Transactions of the Entom. Soc., vol. i. p. lxxviii.

had caused a great waste. The season suited to the propagation of the corn-weevils appears to be uninterrupted, for I have observed them in extensive flour-mills in Norfolk in the spring; in June and July they were abundant in the sweepings of a malt-house in Norwich; in September and the three following months in granaries, and during the winter they attacked and ate up some pearl-barley; and at certain congenial periods the beetles may be seen in multitudes, even on the outside of granaries and malthouses in London.

So important is this subject, that a variety of remedies have been successively proposed for many years, which I shall now consider; and, although some of them may appear trifling, they will not only show how far advanced we are above our ancestors in such knowledge, but they may chance to elicit better modes of application, and even to suggest new ideas. We first hear of fumigation, with herbs having a strong and disagreeable odour; but this seems to have been useless, as the weevils, by burying themselves amongst the grain, are by no means incommoded, whilst the corn has suffered from fetid and disgusting scents which have been communicated to the grain. It is even asserted that the scent of spirits of turpentine appeared to cause the weevils no inconvenience; but I think if it had been persevered in for several consecutive days, excluding at the same time the ingress of air, that it must have destroyed them. The fumes of sulphur are said to be equally inefficient; and all these fumigations are still less adapted to destroy the larvæ, as the smoke cannot penetrate amongst the grain.

Olivier * also says, "Some have imagined, by putting the corn in pannelled cellars, or by sifting it in winter, the corn would be secured from the weevils; but this is a great mistake, for, independent of the difficulty of preventing its germinating and rotting, the weevils would be undisturbed, and more sure to commit their ravages. The sifting is likewise useless in winter, as the weevils have then left the corn-heaps; the eggs are also so well glued to the grain that it is impossible to separate them by sifting or stirring with the shovel. Experiments have proved that a sudden heat of 19° (about 75° Fahr.) is sufficient to destroy the weevils† without burning them; but this would not suffocate the insects when they are buried in a heap of corn. It has been observed

* These suggestions are translated from the Ency. Méth., vol. v. p. 444.

† *Vide* a note a few pages back. The discrepancies and attendant doubts regarding these subjects are fit inquiries to be made by some talented chemist and entomologist; but as the time such experiments and investigations require cannot be expected to be made by scientific men without remuneration, it is to be hoped that some plan may be adopted by the Government in this enlightened age to settle such important questions, which would be doing an essential service to the country.

that a heat of 60° or 70° (167° or 190° Fahr.) is necessary to kill the weevils in the stove; but this excessive heat, which has the advantage of destroying the eggs and larvæ inclosed in the grain, is capable of drying the corn too much, even of burning it, and yet does not preserve it from the insects secreted in the granary, which will come out and attack it if there be no other for them."

In a short communication to the Entomological Transactions, some valuable data upon this point are furnished by Mr. Mills, who was in Madeira from January to August, 1835. In that island he thinks the eggs are first deposited whilst the maize is in flower, and he ascertained that he could hatch the eggs at 110° of Fahr., whilst from 130° to 140° of heat killed them. He adds, "A gentleman of the name of Wilkinson, in Madeira, has now established a heated room with hot-water pipes, in which he receives as many as 800 bags of wheat at a time; these become heated through at about 135°, and the wheat, when resifted, is perfectly cleansed from these noxious insects, and makes quite as good bread as before. I also tried some of it in the ground that had been subjected to this heat, and it came up." *

Olivier then recommends a ventilator to introduce cold air which has already been discussed in the remedies proposed for "the Grain-moth," as well as the forming of little heaps of corn in the spring to act as decoys. He says that when the weevils have taken possession of them, boiling-water should be poured on the heap, at the same time turning it over with a shovel, in order that the heat may penetrate everywhere: it ought afterwards to be spread to dry, and then sifted to free it from the dead weevils. This should be done at the commencement of spring, before the eggs are deposited, by which precaution a fresh generation is stopped.† The introduction of cold air is, I expect, to be recommended for various reasons: at Lynn in Norfolk I have heard it is the practice, and the readiest way of getting rid of the corn-weevils, to expose an empty granary to two or three nights' frost by setting all the windows open.

In a French work we are told ‡ it is an excellent plan "to lay fleeces of wool, which have not been scoured, on the grain; the oily matter attracts the insects amongst the wool, where they soon die, from what cause is not exactly known. M. B. C. Payrandeau related to the Philomatic Society of Paris, that his father had made the discovery in 1811, and had since practised it on a large scale."

After all that has been said, I shall only revert to the necessity

* Observations upon the Corn-weevils, by William Mills, Esq., F.L.S.; Trans. Ent. Soc., vol. i. p. 241.

† Ency. Méthod., vol. v. p. 444.

‡ Bulletin des Sciences Agric., July, 1826, p. 24.

of keeping storehouses clean and aired, and I have the authority of gentlemen of great experience in London to state, that by stirring or turning over the malt frequently, and taking every opportunity of whitewashing the walls, whenever the granaries are at all empty, they experience no loss from the insects I have just recorded.

The corn-weevils are frequently accompanied by several species of small beetles, which assist in reducing the quantity and depreciating the quality of the corn in our granaries. Of course they all belong to the Order COLEOPTERA, and the first is included in the Family CORTICARIDÆ and the GENUS SILVANUS. It is named

SILVANUS SURINAMENSIS—The Corn Silvanus.

From the specific name it may be inferred that this little beetle has been imported originally from Surinam. It is now a constant inhabitant of our stores and warehouses, and from its infesting corn, it was described by Fabricius as *Anobium frumentarium;* and subsequently as *Dermestes sex-dentatum*, from the spines on the sides of the thorax. Linnæus's name having the right of priority, I shall retain it.

9. S. Surinamensis (fig. 24) is only 1 line and a quarter long (*k*), and very narrow: it is flat, of a rusty brown colour, thickly and coarsely punctured, and sparingly clothed with short yellow depressed hairs: the head is large and subtrigonate, the nose appears truncated, but it is semicircular in front, and conceals the mouth, which is composed of an upper and under lip, 2 little horny jaws, maxillæ and palpi: the antennæ are inserted under the reflexed sides of the head, stout, straight, pubescent, nearly as long as the head and thorax, and 11-jointed, basal joint stoutish, 2nd and 3rd obovate, 5 following globose or cup-shaped, the remainder forming an elongated club, the basal and 2nd joints being cup-shaped, the apical one more orbicular: the eyes are black, small, hemispherical, and coarsely granulated: the thorax is perfectly oval and a little broader than the head at the middle; there are 3 ridges down the back forming 2 broad channels, and on each margin are 6 teeth; scutellum minute: the elytra are long, elliptical, and broader than the thorax, with 4 slightly elevated lines down each, between them are double rows of punctures, and series of little shining yellow bristles: beneath them are two ample wings: legs six and short; thighs stout; shanks clavate; feet 5-jointed, 3 first joints short, 4th exceedingly minute, 5th clavate, terminated by 2 claws.

The larva is a little depressed, yellowish-white worm (fig. 22, magnified, *i* being the natural length); it is composed of a tolerably large head with 2 pointed jaws, and 2 little horns, and

of 12 transverse segments; the tail is somewhat conical, and it has 6 articulated legs: the pupa (fig. 23; *j*, the natural length) is of the same colour; the head is bent down; the thorax is suborbicular with 3 ridges; the sides with a few short spines: scutellum elongated; elytra wrapped over the sides and striated; abdomen with distinct segments, the sides with short thick points like the thorax.

Mr. Ingpen bred this insect from bran he received from Scotland; and it appears to be naturalised, from its being found in various parts of England and Scotland under the bark of trees.

Cucujus testaceus—The Corn Cucujus.

This is a still smaller beetle, which accompanies the corn-weevils, and was found by Mr. C. C. Babington in a granary at Cambridge in great abundance, and a closely allied species, or it may be the other sex merely, was observed in granaries and corn-bins in Norfolk about 30 years back in the month of December; at which period Mr. Ingpen detected it in an old decayed elm-tree in Wiltshire. The *C. testaceus*, however, is decidedly a corn-feeding insect, for in examining the wheat from Ancona and cutting open the grains, I found two with the *Cucujus* in them, as shown by the cavity at the top of fig. 13, and more distinctly exhibited at fig. 14 *p*: in this cell, which is opposite to the point occupied by the corn-weevil, the *Cucujus* was lying dead, and there were 2 or 3 little holes in the skin of the wheat as minute as the point of a needle.

This beetle belongs to a small Family called Cucujidæ, which comprises the Genus Cucujus, and from the colour of the insect it has been named by Fabricius

10. Cucujus testaceus (fig. 26): it is only 1 line long (fig. *m*), very narrow and depressed, finely but not thickly punctured, and clothed with short, soft, ochreous pubescence, and is of a bright shining testaceous colour: the head is broad, with a small black eye on each side towards the base; it is narrowed before, and to the nose is attached the labrum, under which are 2 toothed jaws, 2 maxillæ and palpi, and an under lip with 2 more palpi; before the eyes are placed the antennæ, which are longer than the head and thorax, straight, moniliform, hairy, and 11-jointed; basal joint stoutish and oval, the following more or less globose, the three last thickened, top-shaped, and forming a somewhat elongated club, the terminal joint having a little hairy tubercle at the tip: thorax rather broader than the head, somewhat quadrate, but a little narrowed behind, with the angles acute, the sides margined: scutellum small and transverse: elytra very much depressed, elliptical, often slightly concave, broader than the thorax and nearly thrice as long, concealing two ample folded wings: legs 6,

rather small, intermediate pair a little the shortest; thighs stout; shanks slender and simple, with a spine at the apex; tarsi very slender, 5-jointed, first 4 joints very small, 5th long, clavate; the hinder pair is only 4-jointed in the males; claws 2.*

With them I had also the good fortune to find the larva (fig. *l*): it is a little longer than the beetle, narrow, very much depressed, of an ochreous colour, sparingly hairy and formed of 13 segments, including the head, which is somewhat orbicular, with 2 minute antennæ and 2 palpi; it has 6 pectoral, short, articulated legs, the segment at the tail is the longest, semi-ovate, recurved, and terminated by 2 little spines forming a fork: fig. 25, greatly magnified. I have never seen the pupa. Another species of *Cucujus*, apparently the *minutus* of Olivier, infests the maize.

Ptinus crenatus—The oval Ptinus.

Another small beetle is often associated with these insects in old granaries, and by eating into the floors and rafters in which they breed, not only reduces the woodwork to powder, but prepares commodious retreats for the larvæ of the corn-moths and the grain-weevils. The mischief might be prevented, I expect, by Kyanizing the timber employed in such buildings. This Coleopterous insect belongs to the Family Ptinidæ and the Genus Ptinus. From the difference of form in the sexes, the male was described as the *P. ovatus*, and the female as *P. Cerevisiæ* by our countryman Marsham, but it had previously been named by Fabricius

11. P. crenatus. It is of a rusty-brown colour; the male is scarcely 1 line long and $\frac{2}{5}$ broad; the female is sometimes $1\frac{1}{2}$ line long and $\frac{3}{4}$ broad; the head droops and is densely clothed with yellow hairs; the eyes are small, black, prominent, and lateral: antennæ long in the male, filiform, pubescent, and 11-jointed, basal joint stout; the following elongated, terminal one conical; shorter in the female, the joints more ovate-truncate: the thorax is somewhat orbicular, narrowed at the base, very convex, with a central ridge and 2 lateral tubercles, the spaces between them clothed with long yellowish hairs; scutellum very minute; elytra oval, more globose in the female, with lines of punctures and series of yellowish hairs; the legs are of moderate size and pubescent; the thighs clavate; shanks rather long and slender; feet longish, 5-jointed, basal joint the longest, 4th the smallest; claws small.

Uloma cornuta—The horned Maize-beetle.

I ought not to omit mentioning a beetle which not only in-

* Dissections of the mouth, and more ample characters, will be found in Curtis's Brit. Ent., fol. and pl. 510.

habits maize, in the spikes of which it has been found alive in this country, but which I have frequently taken out of bread in London. It is a native of Portugal, and no doubt is imported with the corn. This COLEOPTEROUS insect belongs to the Family TENEBRIONIDÆ and the Genus ULOMA: the species has been described by Fabricius * as the

12. Uloma cornuta. It is tawny-ferruginous, smooth, shining, and very finely punctured, elliptical, and slightly depressed. The male has a broad head, the sides of the clypeus are dilated and form a winged margin, which passes across the centre of the black eyes; between them is a pair of tubercles, and in front project the two curved-pointed jaws: in the female the jaws are small and the margin of the clypeus is simply dilated: antennæ inserted under the clypeus not so long as the thorax, straight, slightly thickening to the apex, 11-jointed, basal joint curved, 2nd the smallest, the following more or less cup-shaped, the terminal one orbicular: thorax transverse-quadrate, the sides a little convex, the hinder angles acute: scutellum minute, semi-ovate: elytra not broader than the thorax, but long and elliptical, the margin a little reflexed, minutely punctured, with ten punctured striæ on each, the 1st short: legs simple; tarsi 5-jointed excepting the hinder pair, which are only 4-jointed: claws 2: length $1\frac{3}{4}$ line, breadth $\frac{2}{3}$ of a line.†

TROGOSITA MAURITANICA—The Cadelle.

The history of this beetle will complete my observations upon the insects which infest granaries and barns. It has evidently been introduced from the shores of Africa, in which country it is abundant, as well as in America, and has now spread itself over a great part of Europe, so that it is common in the south of France in the larva state, and makes very great havoc amongst the corn locked up in granaries; it also attacks dead trees, and even bread and nuts. No doubt the specimens found in this country of the *T. Mauritanicus* have been imported amongst fruits or grain, but it is clear that they colonize occasionally, from the fact that Mr. C. C. Babington found them in the rotten floor of a malthouse in Cambridge. Mr. Kirkup also bred the beetle from a Spanish almond, in which it lived as a larva for 15 months, after which it remained alive as a beetle for 21 months, making a period of 3 years, besides the time it had been in existence previous to its being discovered in the almond.‡

The larvæ are called *Cadelle* in the south of France, and they

* Ent. Syst., vol. i. p. 112, No. 13.

† For dissections, and the other species, see Curtis's Brit. Ent., fol. and pl. 363.

‡ Trans. Ent. Soc., First Series, 1812, vol. i. p. 329.

are particularly destructive, because they eat the outside of the grain, and, passing from one to another, they injure as much or more than they consume. They do the greatest mischief at the end of winter, when they are full grown, and are about 8 lines long and 1 line broad: the body is whitish, composed of 12 segments, distinct enough and rough, with short scattered hairs: the head is hard, scaly, black, and furnished with 2 curved sharp horny jaws: the three thoracic segments of the body bear each a pair of short scaly legs, and a pair of obscure spots; the anal segment is terminated by two very horny hooks (fig. 27; *n*, the natural length). They enter the earth or bury themselves in dust to become pupæ, of which I have no description.

The beetle belongs to the Family TROGOSITIDÆ and the Genus TROGOSITA. Linnæus was well acquainted with this species, which he named

12. T. Mauritanicus, and it is the *T. caraboides* of Fabricius (fig. 28). It is 4 lines long and $1\frac{2}{3}$ broad (fig. *o*), depressed and regularly punctured, of a pitchy colour, with a shade of chestnut; the antennæ are rather short, remote, and inserted in a deep cavity before the eyes; they are clavate, slightly pubescent, and 11-jointed; basal joint stoutish, 2nd minute, 3rd a little oblong, the remainder increasing in diameter, 3 or 4 of the terminal ones forming a compressed club, a little produced internally, the apical joint suborbicular; the mouth is furnished with an upper and under lip, 2 strong bifid jaws, black at their tips and meeting in front, 2 ciliated maxillæ and palpi, which are subferruginous: head broad, semi-orbicular, hollowed on the crown: eyes small, black, lateral, and not touching the thorax, which is broader than the head, semi-orbicular, broadest before, rounded at the base, the sides slightly margined, anterior angles produced and incurved, posterior acute; scutellum small, semi-ovate; elytra broader than the thorax, from which they are separated by a narrow neck and nearly thrice as long, elliptical, a little narrowed towards the base, with 9 delicately punctured striæ on each, the interstices punctured and transversely scratched; wings ample; 6 legs short, anterior pair the stoutest; thighs very short and stout; shanks short, compressed, dilated at the apex, especially the anterior, with 2 minute teeth at the outer and 2 curved spurs at the inner angle; tarsi as long as the tibiæ and 4-jointed, ciliated beneath, first 3 joints short, 4th long and clavate; claws strong and curved.

The beetle is carnivorous, and makes some amends for the mischief it had done in its larva state, by destroying the *Tinea granella*, and it is not yet known where the female deposits her eggs.

Having now by descriptions and illustrations enabled the

reader to identify these pests, and, by tracing their histories, exposed their vulnerable points, it is for those who have the opportunity to follow up the inquiry, and to supply those deficiencies in the economy of the insects, which are wanting to complete the account of their metamorphoses; and I recommend the parties interested in these investigations to practise those remedies best suited to each case, and, above all, to communicate the result to men of science as well as to the public.

There are so many interests concerned in this portion of our subject, that no one could be indifferent to the transformations of these noxious insects, if it were not that an immense proportion of the public is ill informed, or totally ignorant of the silent but powerful operations of nature. There is still one important topic which I have not yet alluded to, but which is deserving of attention. In looking back to the variety of insects that feed upon the corn in granaries, and the multitudes that are often congregated in one heap, there can be no doubt that a very large portion of them must be occasionally ground up with the corn and consumed by the public; this is not only a disagreeable fact, but it may be the source of very serious consequences, for I think it not improbable that diseases might be traced to the insects, which are converted with the infested flour into bread, amounting to such a large per centage, that if they have the slightest medicinal or deleterious qualities, it is impossible to deny the influence they must exercise upon the human system.* I have known bushels of cocoa-nuts, which were every one worm-eaten and full of maggots, with their webs, excrement, cast off skins, pupæ and cocoons, all ground down to make chocolate, flavoured, I suppose, with vanilla!

Summary of the foregoing Report.

Scopula frumentalis inhabits *wheat-fields* in June; the caterpillar is injurious to the crop.

Pyralis Secalis. The caterpillar lives in stems of *rye*, rendering the ears white and empty.

Similar *caterpillars* in *wheat-plants* in March.

A hymenopterous *parasitic fly* infests these *larvæ*.

The *caterpillar* of a moth, *Leucania obsoleta*, will eat the leaves of the *oats*.

They only come out at *night to feed*.

The *slug-like larvæ* of a beetle, *Crioceris melanopa*, feed upon the oat-leaves in June.

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* A medical man in Madeira assured Mr. Mills "that he considered the wings and the crustaceous parts of the weevil so heating to the system as to be almost as injurious as *Cantharides*, taken internally, on a slow scale."—Trans. Ent. Soc., vol. i. p. 242.

The *caterpillar* of a full-bodied moth feeding on the corn in a barn.

They *disliked the light,* and buried themselves amongst the corn.

They *spun* fine but *slight cocoons,* attaching grains and chaff outside, previous to becoming chrysalides.

Numerous grain-feeding *insects imported* with corn.

Cleanliness in granaries an important object in checking their ravages.

Noxious insects much more abundant in the south of France, Italy, &c., owing to the *high temperature.*

This has led to the *cultivation* of *Entomology* generally abroad.

Laws passed for the destruction of insects, and distinguished men engaged by the Governments to investigate the causes of the failure of crops.

Our *cold climate destroys* many imported *insects;* whilst others, more hardy, *become naturalized.*

Insects appear to *progress* from the south-east to the west or north, and often disappear suddenly.

The little corn-moth, *Butalis cerealella,* commits dreadful ravages in France, entailing *famine* and *epidemics.*

It is gradually *spreading itself* in central France, and seems to have reached the United States.

The infested corn *loses* 40 *per cent.* in weight, and 75 *per cent.* of flour.

The *caterpillars* live in the *grain* of wheat, barley, oats, and maize.

The moth deposits 20 *or* 30 *eggs* upon the *grain* in the *field* as well as in the *granary.*

They *hatch* in 6 or 7 days, sometimes in 4 *days.*

The little *caterpillar eats* into the *grain,* only one occupying each kernel.

When the flour is all consumed it *changes* to a *pupa* inside the *husk,* which it lines with a silken *web.*

The *grains* at this time *appear* perfectly *sound* to the eye, but are *soft* to the touch.

They seem to *devour* their own *excrement* once or twice.

The end of *November* there are many *caterpillars* in the *grain,* in the *spring* mostly *pupæ.*

Some of the *eggs* hatch much earlier than others.

The *moths* appear the beginning of *May* or in *June,* and again in *November.*

They make their way out of the grain through a little hole cut by the caterpillar, and *live* only 2 *or* 3 *weeks.*

A parasitic fly, amounting to 20, is sometimes hatched from one pupa.

The *moths* hatched in *May* escape by the *windows*, those that are born after *harvest* remain in the *granaries*.

The *caterpillars* and *chrysalides* may be *killed* by applying *heat*, and its moderate action for a certain period is more efficacious than intensity for a short time.

An *insect-mill*, like a coffee-roaster, at a temperature of about 167° *of Fahrenheit*, will deprive the beetles of *life* in the *grain*.

Corn submitted to this heat is not more subject to *ferment*, nor to be *devoured* by insects, nor is it less capable of *vegetating* than that which has not undergone the operation.

The *expenses* attending it do not amount to *three farthings per bushel*.

Another machine for *shaking* the grain is expected to destroy the insect in its different stages.

The *Wolf*, or little grain-moth, is abundant in our *granaries* from *April* till *August*.

The *caterpillar* does incredible mischief to *bonded corn*, feeding on wheat, barley, rye and oats, and it is said also on old timber, books, boxes, woollen stuffs, &c.

The female *moth* lays about 30 *eggs*, depositing one or two on each grain.

The *caterpillars* hatch in 16 *days* or less, and penetrate the grain, eventually uniting several together by a web.

They sometimes *cover* the whole mass of *corn* with a *web* 3 inches thick.

In *August* or *September* they are *full grown*, and leave the corn-heaps, and change to chrysalides in a web in the floor, walls, or roof, and will even eat into the knots of fir saturated with turpentine.

They live there as *larvæ* until *March*, or even *May*, when they are transformed to *chrysalides*.

The moth deposits its *eggs* on the *sheaves* in the *field*, as well as on the *corn* that is *housed*.

Before *filling* an empty *granary*, *cleanse*, scour, and whitewash it thoroughly, in the *winter* if possible.

Other remedies, by the application of *heat* or *cold*, should be tried in *summer*, when the larvæ are at work.

The *moths* may be *destroyed* in the spring by *burning lamps* or *gas-lights*, at the same season *turn over* the corn to *destroy* the *eggs* and disturb the young *caterpillars*.

Plaster the *walls smooth* inside, filling up all cracks, &c. *Stop* all *apertures*, covering those for ventilation with wire-gauze.

Kiln-drying at about 78° Fahr. will *kill* the *larvæ* when they are feeding.

The *caterpillars* cannot bear a lower temperature than 55° Fahr.; they became torpid at about 46°, and soon *die*.

Cold currents of air, introduced by small windows near the floor, is a sure remedy.

Burning sulphur, and creating sulphuric acid, will *kill* the *moths* in a close apartment.

Corn has thus been kept by the party recommending this mode for 6 *years.*

It is feared the *caterpillars* will *escape* the fumigation by burying themselves in the corn-heaps.

Scattering salt over the corn is beneficial, and if powdered and mixed with the corn will *kill* the *caterpillars;* or it may be dissolved in water and sprinkled over the heaps.

A small *heap of corn* left *undisturbed,* frequently turning over the rest, is a sure and simple plan of *catching* the *larvæ,* and they can easily be destroyed by pouring boiling water over.

Diseased corn should be *sown deep,* to prevent the moths escaping from the chrysalides.

If *corn* be left long standing in the *field,* the moths soon deposit their *eggs* in the *ears.*

Bats, spiders, and *small birds* are the natural *enemies* of the Grain-moth.

The *Rice-weevil* is found amongst rice, and in *wheat* imported from Italy, in *granaries* and in *ships.*

The *maggot* lives in the grain, and *feeds* on the *flour.*

The *grains appear sound* outside, with a minute hole towards the bottom.

About *ninety-five per cent.* of the *flour* destroyed in a sample from Ancona.

The *pupæ* are similar to those of other Weevils.

An *apterous parasitic insect,* one of the *Diplolepidæ,* preys upon them.

The *Granary-weevil* bores a hole in the *grain* of wheat, and deposits an *egg* in it.

The *maggot* lives in the *grain,* changes to a *pupa* there, and in *eight or ten days* the *Weevil* eats its way through the skin.

Only *one maggot* lives in *each grain,* and it is in this state they do so much mischief, although the *Weevils* are believed to feed upon the *corn also.*

If the temperature be kept under 50° *Fahr.* the *sexes do not pair;* and they do no further mischief.

When it is *cold* the *Weevils* become *torpid.*

In *April they pair,* if the temperature be 54°, and they go on *propagating* until the end of *August.*

The *warmer* the *weather* the more *eggs* are deposited, but the females *cease to lay* when it becomes *cold.*

So fast do they *multiply* in the south of France, that sometimes in a *corn-heap* nothing but the *husks* are *left.*

It does not take more than *six weeks* to undergo all the *changes*, from the laying of the egg to the hatching of the Weevil.

It is calculated that 6045 individuals may be reared from *one pair* of *Weevils* in a *summer*.

As soon as the *female* is *impregnated*, she *buries* herself in the corn-heap to lay her eggs.

The presence of these *insects* in the grain *cannot be detected* by looking at a corn-heap, but on throwing the *grains* into water they *float*.

As long as the *weather* remains *hot*, the *Weevils* keep in the *corn-heaps*.

When the *mornings* become *cool*, they leave them, and *secrete themselves* in crevices and chinks in the walls, wood, &c.

The *Weevils* do not like *light*, and bury themselves if possible when exposed to it.

The *Granary-weevils* are never found in the *fields* in *England*, and consequently the *eggs* are only laid when the *corn* is *housed*.

The *Granary-weevil* can bear our *climate* much better than the Rice-weevil.

In the East and West Indies *Calandra Oryzæ* is exceedingly abundant in the *magazines*.

They expose the *grain* to the *sun*, and *winnow* it frequently.

Barley and *malt* suffer most from the *Calandra granaria*. On placing the *beetles* in a box with *barley*, *maize*, wheat, peas, and beans, they only attacked the two first; but in other instances *wheat* and *black oats* were devoured.

In mild seasons the *Granary-weevil* may be found *all the year* in warm granaries and mills; and in *sultry weather* on the *outsides* of the *buildings*.

Fumigating with strong-scented *herbs* only communicates a disagreeable *odour* to the *grain*, as the Weevils escape by burying themselves in the corn.

The scent of *spirits of turpentine* did not appear to incommode the Weevils, but it would, if persevered in, at the same time excluding the atmospheric air.

The *fumes* of *sulphur* failed from the same cause, and still less affect the larvæ contained in the grain.

Placing the corn in *close cellars* the worst of all proceedings, as the *Weevils* delight in *darkness* and being *undisturbed*.

Sifting in the *winter* useless, as the *Weevils* are *not* then in the *corn-heaps*.

A sudden heat of 75° Fahr. will *destroy* the *Weevils*, but it will not suffocate them when buried in the corn heaps.

The *eggs* and *larvæ*, as well as the Weevils, are destroyed by 190° *Fahr*., but it also scorches the corn.

In *Madeira* the *eggs* are believed to be laid in the *flowers* of the *maize*.

The *eggs* are *hatched* at 110° Fahr., whilst 130° to 140° *killed* them.

A room heated to 135° by hot *water-pipes* has been constructed in Madeira, which answers every purpose.

The *wheat* subjected to this high temperature *vegetated* in the ground.

In Norfolk the *windows* of an empty granary are *set open* for two or three nights during a *frost,* which expels the Weevils.

Fleeces of wool laid on the corn-heaps *attract* and *kill* the *Weevils.*

In London the *malt* does not suffer from these pests when *white-washing* the granaries and frequently *stirring* or turning over the heaps are *regularly attended to.*

A little beetle, called *Silvanus Surinamensis,* with its larvæ and pupæ, sometimes abound in *granaries.*

It inhabits *bran* also, and is found under the *bark of trees.*

A smaller beetle, called *Cucujus testaceus,* has been found in great abundance in *granaries* and *mills.* It has also been detected under the *bark* of elm-trees in *December.*

Inhabited the *wheat* from *Ancona,* with its larva.

Another species, the *Cucujus minutus,* infests the *maize.*

Ptinus crenatus often accompanies them, *eating* into the floors and *wood-work.*

Kyanizing the timber used, the best remedy against their inroads.

Uloma cornuta is a beetle, which inhabits the *maize-spikes,* and is often found in *London bread.*

The *Cadelle* is the larva of a beetle which is mischievous in *granaries,* especially in the south of France.

It inhabits also *dead trees,* and will attack *bread* and *dried fruit.*

It has been *imported,* and a colony of them was found in the floor of a *malt-house* in Cambridge.

It was bred from a *Spanish almond,* in which it *lived* as a larva and beetle for *three years.*

The *Cadelle* eats the *outside* of the *grain,* injuring more than it consumes.

These *larvæ* are most troublesome at the *end of winter,* and become *pupæ* in the *earth* or amongst dust.

The beetle is called *Trogosita Mauritanica,* and devours the *Tinea granella.*

These *insects* ground up with our *food,* in all probability *injurious* to the *constitution.*

Chocolate sometimes manufactured from *cocoa-nuts* swarming with *insects.*

EXPLANATION OF PLATE P.

Fig. 1. A grain of wheat opened, to show the cavity in which the caterpillar of *Tinea granella* had fed, with the excrement at the apex.
Fig. 2. Several grains united by the same caterpillar.
Fig. 3. The caterpillar of *Tinea granella.*
Fig. 4.* The same magnified.
Fig. 5. A group of the cocoons spun by the same.
Fig. 6. The *chrysalis* taken out of a cocoon.
Fig. 7.* The same magnified.
Fig. 8. A *chrysalis* sticking in a cocoon after the moth was hatched.
Fig. 9. *Tinea granella* at rest.
Fig. 10.* The same flying, and magnified.
q. The natural dimensions.
Fig. 11. *Calandra Oryzæ*, the Rice-weevil.
Fig. 12.* The same magnified.
*a.** One of the mandibles or jaws.
*b.** The maxilla.
*c.** The palpus or feeler.
*d.** The antenna or horn.
Fig. 13. A grain of wheat opened, to show the burrows of two beetles.
Fig. 14.* The same magnified.
e. The maggot of *Calandra Oryzæ.*
p. The burrow of *Cucujus testaceus.*
Fig. 15. A grain of wheat.
f. The hole eaten by the *larva* of *Calandra Oryzæ.*
Fig. 16.* The same grain magnified.
f. The hole perforated by the little maggot.
Fig. 17.* The grain of wheat opened to show the perfect weevil inside.
Fig. 18.* The *pupa* of *Calandra Oryzæ.*
g. The natural size.
Fig. 19.* The parasitic fly, *Meraporus graminicola.*
h. The natural size.
Fig. 20. *Calandra granaria*, the Granary-weevil.
Fig. 21.* The same magnified.
Fig. 22.* *Larva* of *Silvanus Surinamensis.*
i. The natural length.
Fig. 23.* *Pupa* of the same.
j. The natural length.
Fig. 24.* *Silvanus Surinamensis.*
k. The natural length.
Fig. 25.* *Larva* of *Cucujus testaceus.*
l. The natural dimensions.
Fig. 26.* *Cucujus testaceus.*
m. The natural size.
Fig. 27.* *Cadelle* or *larva* of *Trogosita Mauritanica.*
n. The natural length.
Fig. 28.* *Trogosita Mauritanica.*
o. The natural length.

P

Obs.—Those numbers and letters with a * attached refer to the objects which are represented larger than life. All the figures are drawn from nature, excepting Nos. 3, 4, 5, 6, 7, and 8, which are copied from Roesel, and 22, 23, and 27 from Westwood's Modern Classification.

Hayes, near Uxbridge, May, 1846.

VI.—*On the best Method of Draining Running Sands.* By William Linton.

Prize Essay.

The draining of strong tenacious clays, and that of running sands, that their respective objects may be secured, certainly call for the closest observation, the most diligent and careful inquiry, and the soundest science and skill in all who are engaged therein, in order that the former may be rendered effective, and the latter permanent.

My intention is not to add to this Essay by any lengthened introduction, but to proceed at once to give an account of what I have myself witnessed—an account which will extend through an experience of twelve years. During that period I have been engaged in draining a great variety of soils, but especially the running sand; the greatest part of which had been previously drained, but on account of the shallowness of the drains, which were not more than from 12 to 18 inches deep, their having been covered with perishable materials, and not having bottoms, which allowed the moles to do great mischief by their subterraneous burrowing, had become entirely choked up, and consequently useless.

The land in question has a very light grey, sandy surface. The subsoil is white sand, which varies in depth from 12 inches to 6 feet, beneath which lies, of a considerable thickness, a bed of marly clay. To attempt here to fix any stated depth at which drains should be laid is in my opinion absurd, as that is a question which can only be determined by ascertaining the depth at which the water lodges; which may be known by digging holes in different parts of the field previous to commencing the work, and as soon as the stratum which contains the water is cut through, it will at once be seen by both sand and water gushing into the opening, and undermining the earth around it. For the most part, when my drains are cut to the depth of about 18 inches, a small stratum of the quick running sand and water is found, and at about 18 or 20 inches deeper one containing a much

larger quantity of water is cut into, which is about 3 inches in thickness; beneath it lies the marly clay upon which we generally lay the tiles. But it sometimes happens that on the higher parts of the field the clay referred to cannot be reached, on account of the increased thickness of the sand. Still when this is the case, the sand beneath the stratum of water, on account of its elevation, is of a firmer and drier kind, upon which we can with confidence place the tiles, never having found them to fail when a rapid descent was avoided. To reach the clay in every place is not practicable. The average depth of the drains is about 3½ feet.

The manner in which the work is done is as follows:—The first object is to ascertain the depth at which the bottom water lodges. If deep, and the earth very porous, the drains are set out much farther apart than when it lies near the surface. Thus they are varied in their distance from each other in proportion as the water lies deep or otherwise; that is to say, when we can cut to a depth of 4 feet in that which is entirely porous, the drains are set 15 yards apart, and when we find the water to lie as deep as 6 feet, their relative distance is 20 yards. But when the clay lies near the surface, being only about 12 inches beneath it in some instances, they are set out only 8 yards apart.

Having ascertained the proper depth and relative distances of the drains, the outlet is next attended to, a point which is frequently too slightly regarded, and consequently often proves injurious, and sometimes entirely ruinous to the whole work. When this is accomplished, the drains are set out as above. The land, which is very undulating, is cut to a certain level depth throughout, so as to give a gradual and proper descent towards the outlet, and so deep as to only require two draws or spits to be taken out afterwards. The earth at the top being thus removed, the level is then used (as from the porousness of the land no water by which the descent might be taken, runs so near the surface), and the greatest care is taken at this stage of the work to have all thoroughly true, and the descent given that is required, as the finishing depth and the fall are ruled by the top levelling, before the two spits referred to are taken out. To cut the drains deeper before using the level would be to render the use of it almost impracticable.

All is now ready for completing the work, tiles and bottoms being laid by the side of the drain, and three men engaged in the work; two of the most experienced to cut the drain to its proper depth, the one following the other in as short a space as possible, and the third immediately following with the bottoms and covering. The main drains are laid either with large-sized tiles and bottoms, or with two common ones, one upon the other,

the lower one being reversed, and the upper placed upon its edges half the length of the tile backward, that the ends of the upper and lower tiles may not come together, which will break the joinings throughout the whole drain. If the latter plan be adopted, the minor drains are laid level with the edges of the reversed tile; if the former, about two inches descent is given at the entrance of the main drain.

All rapid falls are particularly avoided, or the drain will wash away in spite of all precaution, especially where a strong run of water occurs. Where a fall of 1 in 100 cannot be avoided, it is necessary to beat clay into the bottom of the drain under the soles. In setting out the minor drains, the distance of each is regulated, as already pointed out, according to the openness of the land and the depth of the water. All long runs are also avoided, the length being no more than from 3 to 5 chains. I need scarcely say that the whole of the land is thrown level, so that there is neither ridge nor furrow to regard.

We shall now consider the most important and critical part of the work, which is the taking out of the bottom spit, and the laying of the tiles and bottoms; but most of all, the securing of the tiles from admitting the quick running sand. The two men who cut the drain to its proper depth, work as near to each other as possible, and the tile-layer quite up to the latter, or the drain would be immediately closed up by the sand running in from the sides, which would also let down the mass from the surface. In other words, when the first man has got a few feet from the end of the drain, the second commences taking out the bottom spit, and as soon as he has made way for the laying of three or four tiles, it is immediately done by the tile-layer; first laying the bottoms quite close to each other, and upon them the tiles, leaving as little crevice as possible, and immediately covering them with about 4 inches of the most tenacious soil that can be procured. Clay would be used, but on account of its being in large hard lumps, it cannot be made to bed sufficiently close to keep out the sand. Here I must notice, that it is essentially necessary that the drains be cut 3 or 4 inches wider at the bottom than the width of the tile, so as to admit this strong soil down the sides to the very bottom. Much mischief is done by the sand getting in at the bottom part of the joinings of the tiles. Other materials have been used for keeping out the sand, but with bad effect. I prefer clay to anything else when it can be got sufficiently loose and malleable, so as to bed quite close and firm, and leave no crevice. Straw, and all perishable materials, are particularly avoided.

When the season is wet (although from many considerations a dry one should be chosen if possible), and when the drain is deep, great difficulty is found in keeping the sides from falling in before

the tiles and first covering can be deposited. I have frequently found it necessary to fix planks to the falling sides, supported by cross-stays, to prevent accident, and keep the drain open until the work be completed.

After the clay or strong soil is well trodden in and thrust down the sides of the tiles with a common spade, the sand thrown out in making the drain is then filled in, and is firmly beat down by treading, and sometimes by running a broad-wheeled cart upon it, in which is put a sufficient weight, in order that the covering of the drain may become as firm as any other part of the field. This is done to prevent the water from descending or finding a channel to the tile in that direction, or it would be almost impossible to keep out the sand.

Sufficient has been said by different authors, especially in those Essays which are published in the Royal Agricultural Journal, as to the proper and natural course of the water—how it does and ought to enter the drain—without my entering at all into that part of the science of draining.

On account of the quantity of labour required in forming the drains, varying according as the land is wet and undulating, and again, the desideratum being rather permanent and well-executed work, than a large amount of it, I have had the work done, for the most part, by the day rather than by the piece. Notwithstanding I have occasionally stipulated for the cutting of the two bottom spits, which together sink the drain about 30 inches, at the rate of 3½*d.* per 7 yards. The tools required are the common spade, shovel, draining-tool, and what is called the swan-necked scoop for cleaning out the bottom of the drain.

The pipe-tiles having been of late introduced into this neighbourhood, I have commenced using them. The drains are cut, and every other part of the work performed in the same way as when the common tiles are used. But on account of the land having been but recently drained by them, my observations are not sufficiently matured to justify me in saying that they are in all respects equally good with the common tiles. I find it sometimes difficult to get them to fit close enough to each other, the ends not being quite straight, and some of them curved in the middle; therefore it is necessary to apply clay to most of the joinings.

Of these running sands I have drained about 500 acres, and when the plan which has been stated here at large was adopted, which has generally been the case, the average cost per acre was about 5*l.* 5*s.*; that is to say, 1500 tiles, at 26*s.* per thousand; 3000 bottoms, at 11*s.* per thousand; cutting, 1*l.* 10*s.*; and incidental expenses, 3*s.*; total, 5*l.* 5*s.*

I shall now conclude these remarks by stating the result of these operations in draining, which indeed must be considered in

conjunction with marling. The land in question was an enclosure of barren heath, and had been considered, and really was, previous to being drained and marled, worthless. It has now become profitable tillage-land, and is advantageously cultivated under the four-course system. But to attempt such a work without carrying out the two great parts of agricultural improvement which these soils invariably require—namely, draining and marling—is, I think, superficial and unwise, and is always attended with disappointment and loss.

Sheriff-Hutton, near York,
27 *Feb.* 1846.

VII.—*On Measure Work.* By Hugh Raynbird.

Prize Essay.

Believing that the Society's object in proposing a prize for the best account of measure-work is to induce competition among those who by observation have become acquainted with its practice, and living in a part of the country where a good portion of the hoeing, ditching, reaping, mowing, threshing, and other kinds of agricultural labour are performed by piece-work, I am induced to offer the following description of our mode of proceeding.

In commencing the details of the system of measure-work adopted by us, and by the farmers in our neighbourhood, I shall labour under much difficulty; for I chance to belong to that class of homespun farmers who are perhaps better able to work with their hands than they are with their heads, and are generally better qualified to perform the manual operations of the farm-labourer, than to write an essay upon the subject. However, I hope the want of skill in composition will serve as an apology for the errors that may appear.

There are many ways of paying the labourer, peculiar to different parts of the country; but the chief difference lies between the day-labourer, who receives a certain sum of money, or its equivalent in other things, for his day's work, and the task-labourer, whose earnings depend upon the quantity of work done. The employment of men by task-work has been practised in this county (Suffolk) almost from time immemorial, if we may be allowed to judge by the following interesting extracts from Sir John Cullum's History of Hawstead, his information being obtained from authentic sources:—

"In the year 1281 the prices of various kinds of grain, the produce of this village (Hawstead, Suffolk) were as follows: of wheat, from 4*s.* 3*d.*

to 4*s.* 5*d.* a quarter; of barley, 3*s.* 6½*d.*; of new peas, 2*s.* 9½*d.* to 2*s.* 11½*d.*; of old peas, 2*s.* 4½*d.*; of oats, from 2*s.* 2*d.* to 2*s.* 4*d.* This was a year of moderate plenty, and may therefore be considered as the standard of the prices of grain about this period. In the same year, 1281, the price of a bullock was 8*s.* 6*d.*, of a hog 2*s.* 6*d.*, of a pig, 6*d.*; of threshing a quarter of wheat, 3*d.*; of silico (a white wheat), 2½*d.*; of barley, 1½*d.*; of peas, 2*d.*; of draget (barley and oats mixed), 1*d.*; of oats, 1*d.*

"In 1389, wheat sold for 4*s.* and 5*s.* a quarter; barley for 3*s.*; oats for 2*s.*; bolymong (peas and beans grown together) for 2*s.* Wheat was threshed for 4*d.* a quarter, barley and peas for 2*d.*; meadow-ground was mown for 6*d.* an acre; malt made for 6*d.* a quarter.

"In 1388, 30 acres of oats tied up by the job (per taskam), 1*s.* 8*d.*; 6 acres of bolymong (beans and peas), cut and tied up by the job, 3*s.* 1*d.*; 16 acres of peas cut by the job, 8*s.*; 5 acres of peas and bolymong cut and tied up by the job, 2*s.* 6*d.*; 3 acres of wheat cut and tied up by the job, 1*s.* 11*d.*

"In 1389, 212 reapers hired for one day, 3*d.* each, besides their board; 13 acres of wheat cut, tied up, and treselled (treseland) at 7*d.* an acre; 1 acre of oats cut, tied up, and treselled at 5*d.*;—6 yards of canvas for the table, 12*d.*; grinding 5 quarters 1 bushel of malt, 8*d.*

"In 1682 the following wages of labourers were rated and appointed by the justices of the peace, at their quarter-sessions holden in the town of Bury St. Edmund's:—

"Wages by the year—

	£.	*s.*	*d.*
A bayliffe in husbandry	6	0	0
A chief husbandman or carter	5	0	0
A 2nd husbandman or common servant above 18 years of age	3	10	0
Under 18 years of age	2	10	0
A dairy-maid or cook	2	10	0
The best hired servants, with meat and drink for harvest	1	2	0
An ordinary harvest-man	0	18	0

"N.B.—Without meat and drink, their wages were doubled.

"Wages by the day—

A man haymaker, with meat and drink	0	0	5
A woman haymaker	0	0	3
A man-reaper in harvest	0	0	10
A woman-reaper	0	0	6
A common labourer at other times (in summer)	0	0	6
,, ,, ,, (in winter)	0	0	5
Women and weeders	0	0	3

"At this time (1780), a head servant who lives in the house, receives for wages, 7 or 8 guineas a year; a maid, 3 guineas; a boy, 2 guineas; a day-labourer has 1*s.* 2*d.* in summer, and 1*s.* in winter, besides an allowance of beer; for threshing a coomb of wheat 1*s.*, of barley and oats 6*d.* or 7*d.*; for mowing an acre of grass, 1*s.* 4*d.*; a weeder of corn has 6*d.* a day."

These details, collected by Sir John Cullum, though in some measure foreign to my subject, sufficiently prove that our present practice of letting out piece-work is far from being a modern one; and the manner in which it was conducted has in all probability remained in many respects without any great alteration. From these records we may also make a comparison—as Sir J. Cullum has done—of wages anciently paid, with those of the present time.

A system of measure-work may be used with advantage to the farmer, in almost every kind of agricultural labour, with the exception of that in which horses or other cattle are particularly engaged: other exceptions are jobs of short duration, and the tending of sheep or cattle.

Piece-work holds out to the labourer an increase of wages as a reward for his skill and exertion, and as he knows that all depends upon his own diligence and perseverance, he becomes more interested in his employment than the day-labourer. The task-worker is also more independent in his character, which arises from the knowledge that so long as he performs his work to the satisfaction of his master, he is not under that control to which the day-labourer is always subject. But though the labourer by task-work will not require the eye of his employer to stimulate him to industry, he must not in any way be allowed to abuse the confidence placed in his honesty, by slighting or hurrying over his work. Regular taskmen, however, are much less likely to be careless than day-labourers only casually set to work by the piece, and to prevent deception, as well as to acquire a knowledge of the value of labour, the keeping correct accounts is absolutely necessary: this is generally done by means of a journal in which the employment of the men is entered every day, and the amount of money advanced at the time of payment. By adopting this plan, the sum earned per day may easily be ascertained, and a fair price be adjusted between master and man. Another way will be for the farmer to take the quantity of work done by a day-labourer in a given time, and from this calculate the price to be paid by task. However, there must always be an uncertainty attending this, arising from circumstances over which the farmer has no control; and we must be guided in fixing a price by the nature of the soil in some operations, and in others by the bulkiness of the crop: work in which the spade or shovel is used, such as draining, ditching, filling soil into carts, trenching, and digging, the nature of the soil will affect the quantity of labour; mowing, reaping, and all harvest operations, whether with corn, hay, or roots, will depend in a great measure upon the bulk of the crop.

Among the advantages of task-work to the labourer are—

1. The occasional employment of his wife and children, who in some kinds of work render material assistance, and add considerably to the earnings of the married labourer.

2. It gives the labourer habits of exertion, for he finds his earnings depend entirely upon the diligence which he exercises; and should the labourer even be inclined to be indolent, he will be obliged to perform an equal share by his fellow-workmen.

3. It stimulates the skilful labourer to learn the best and quickest way of doing his work; for he well knows that he is certain of employment at a good price, if he is able to perform his work in a superior manner; and the quick dispatch of labour will add to his earnings.

4. The wages of a steady and industrious task-labourer will amount to more than the earnings of the day-labourer, and therefore he may live more comfortably.

5. He becomes more respectable and independent in his character, and he takes more concern in his master's affairs and well-being than the day-labourer.

The advantages of task-work to the farmer or employer are as follow:—

1. The quick dispatch of labour; for in hay and corn harvests, as well as in hoeing root-crops, it is often of the utmost importance to have the work performed as quickly as possible.

2. A greater quantity of work may be done for a given sum of money than by employing day-labourers.

3. Task-men do not require so much looking after as men engaged by the day.

4. The farmer can employ his steady and skilful labourers by the piece; by thus giving the preference to the labourers who execute their task in a workmanlike manner, he renders them a pattern for the other men.

In most kinds of task-labour I would not advise the employment of many labourers in one company; though in hay and corn harvest, sowing turnips on the drill-system, dibbling wheat, and in some other cases, a combination of force is necessary. The objection to great numbers being together is, that there may be some men of loose habits, who will induce the others to spend a portion of their earnings in drink;—when this is carried to any extent the work is in general done badly. As an instance of the bad effects produced on the moral conduct of the labourers themselves by the promiscuous employment of great numbers of both sexes, we may mention the gang-system practised in parts of Norfolk and Suffolk; and which is a great cause of vice and demoralization among the class of people who are obliged to

work in them. In this practice a man called the ganger or undertaker agrees with the farmer for certain work, generally hoeing wheat and turnips, harvesting and storing away root-crops, dibbling wheat, or any light work in which women and children are employed. The undertaker having made a bargain with the farmer, gets together an assemblage of labourers of all descriptions and characters from the neighbouring towns and villages; these have often to walk some distance to their work, and are then exposed to all the corrupting influence of bad companions; their wages are uncertain, for as soon as the weather becomes unfavourable or the job is ended, they are thrown out of employ. To take the place of the gang I would either have a steady man, paid a shilling or two a week extra, to superintend the children, or put out work in which they are required to men with large families, who would then have an opportunity of overlooking the behaviour of their own children.

The measurement of task-work may be most exactly taken by the chain for land and the length of drains and ditches, and the tape for taking the cubic contents of heaps of soil and manure, the dimensions of clay-pits, and the square contents of thatching. I need hardly remind the farmer of the assistance he may obtain from the agricultural table-books, which will be found very useful, and may be had at a price within the reach of every one.

The rates of payment for task-work given by me are those paid during the last ten years; the day-wages have been successively 8*s*., 9*s*., and 10*s*. a-week; the present wages for a common day-labourer are 10*s*. for summer and winter; during harvest upwards of 1*l*. a-week is earned, and in haymaking time beer is given in addition to the common price of a day's work. A woman working from eight in the morning to six in the evening has 8*d*. or 10*d*. a-day.

The usual hours of day-labour with us are in summer from six in the morning to six in the evening, in winter as long as it is light; out of this the labourer is allowed 1½ hour for breakfast and dinner. Men employed with horses work from six in the morning to half-past two in the afternoon,* including a short time for breakfast: during harvest, from five in the morning to seven in the evening, or as long as the farmer pleases; out of this they rest about two hours.

The quantities of the various kinds of work which I shall state as performed in a given time, are taken from task-work

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* I find it a much better plan for horses and men to bait the horses for an hour, excepting in the shortest days of winter, and in summer to let them lie by for two hours, or even for three, during such heat as we have lately experienced.—Ph. Pusey.

To this I agree after experience.—Portman.

actually done by labourers in our employ, and may therefore be considered an average; though, from many causes, it is impossible for one quantity or one price to be taken in every case or situation.

The standard measures are always used; for by adopting these I am more likely to make myself understood by the greater part of my readers than if I had used any of those obsolete local measures, which I am sorry to see in use in certain parts of the country; they are the cause of many mistakes which might be remedied by adopting the standard weights and measures.

In detailing the various operations to which a system of measurement is applicable, I shall divide my subject into separate heads, to each of which a distinct mode of measurement is suited.

1st. The kind of task-work to which land or square measure is applicable, the work being paid for by the acre, rod, or square yard.

2nd. The kind of task-work to which lineal measure is applicable, the work being paid for by the chain, rod, or yard in length.

3rd. The kind of task-work to which solid or cubic measure is applicable, the work being paid for by the cubic yard or load.

4th. The kind of task-work to which corn-measure is applicable, the work being paid for by the quarter, sack, or bushel.

5th. Task-work performed by various kinds of measurement.

1. *Task-work to which land or square measure is applicable.*

Table of Land-Measure.

9 square feet . . .	1 square yard.
30¼ square yards . . .	1 square rod.
40 rods	1 rood.
4 roods or 10 square chains .	1 acre.

In using land-measure as a means of calculating the earnings of labourers by the piece, it is usual to let or put out the job at a certain rate per acre for such work as mowing, reaping, and hoeing, in which a large quantity of land is gone over; but for trenching and digging in small quantities the square rod is most convenient.

1. *Mowing permanent meadow-grass for hay* is the first operation that will come under our notice; it is one of those operations of husbandry which require to be executed with dispatch, as by its being quickly performed the hay-harvest is shortened, and every advantage may be taken to secure the produce in fine weather. This is of great importance in the hay-country around London, where, in the season of hay-making, mowers are in great request, and command high wages. In Suffolk, the rate for mowing varies with the bulk of the crop, from 2*s.* to 2*s.* 6*d.* per acre: beer is frequently allowed in part payment for mowing; the work is then done at 2*s.* and half a gallon of beer for each

acre. The hours of labour in mowing grass are from five in the morning to seven in the evening, stopping two hours in the meantime; they thus labour twelve hours in a day, during which an expert mower will cut 1¼ acre; the generality of men will earn in money about 3*s*. a-day. The cost of cutting low meadow-grass is rather higher than of cutting upland. Mowing clover and rye-grass is generally more quickly performed, and consequently the rate per acre is lower. I find the average price per acre is 2*s*., or 20*d*. and half a gallon of beer; the quantity mown in a day nearly 1¼ acre; the earnings of a man will thus vary from 2*s*. 6*d*. to 3*s*. The cutting seed-crops of clover and rye-grass does not greatly differ from the mowing for making into hay. Men engaged to mow grass by the day have 2*s*. and an allowance of beer; but they cannot of course be fairly expected to work so hard if paid in this manner. The making grass into hay is occasionally put out by the job at the rate of 4*s*. an acre for mowing and making; this gives ample employment to the wives and children of the mowers. But the farmer must not be guided in his opinion of the right time of carting by his men, for if he is he will in all probability have it carted before it is in a fit state for stacking.

2. *Mowing wheat* is a practice coming into use in preference to reaping; the rate paid per acre depends of course upon the bulk of the crop, and on the abundance of labourers during harvest: for a light crop 6*s*., and for a heavy one 8*s*. are paid per acre; this includes mowing, tying, shocking, and raking. The mowing constitutes barely half the labour, though the making and binding the sheaves may be done by boys; a strong lad will make and bind sheaves as fast as one man mows. A man in a day of ten hours will mow upwards of an acre, and with the assistance of another man, or of two boys, he will be able to complete the other operations required in cutting an acre of an average crop of wheat.

3. *Reaping* is also generally done by the acre, and in seasons when the crop is heavy or lodged by rain, it becomes a tedious labour; the price per acre for a medium crop of wheat that stands upright is about 8*s*.; but if the wheat is lodged, from 10*s*. to 12*s*. A good reaper will sometimes cut more than half an acre in a day, but the generality do not cut more than one-third. Reaping beans costs about 6*s*. an acre. Strangers are frequently employed to mow or reap wheat; I consider it a good plan to supply them with beer at the rate of a gallon for each acre: this will greatly influence the workmen, as they then will have no occasion to go to the beer-shops for drink sold at a high price. The cost to the farmer will be but little, as he can brew beer for the purpose at about 6*d*. a gallon.

4. *Mowing Barley or Oats* is usually included in the contract

for harvest, of which I am about to give a description. A man will cut upwards of 2 acres of barley in a day; of oats he will not be able to get over quite so much.

5. *Harvest-work* is generally put out by task. Some farmers give a certain price per man to a company, who agree in return to do all the harvest-work in cutting, carrying, and stacking the corn, to which an acre or two of turnip-hoeing for each man is sometimes added. Others hire a sufficient number of men, for four or five weeks, at a certain sum for that time; this method is mostly practised by small farmers, who work with the men and keep them from loitering, for otherwise there would not be much inducement for the labourers to hurry. On the larger farms two distinct modes of hiring are sometimes adopted: the men are divided into two companies—one called the crop-men, who engage to cut a certain number of acres of wheat, all the barley, oats, peas, beans, or any other crop that may be grown on the farm, to pitch and load all the corn, and to turn a portion of it when required; to this is added a certain quantity of turnip-hoeing, about one or two acres for each man. The yard-men, as the others are called, are hired by the month or five weeks; their labour is of various kinds, though principally confined to cutting wheat, unloading and stacking corn, and any other labour that may require to be done. An able-bodied man is usually paid 4*l*. 10*s*. and 3 bushels of malt for five weeks' certain employment; while the crop-men, who work by the job, have from 4*l*. 10*s*. to 5*l*. and 3 bushels of malt, whether their harvest is of long or short duration.

On a farm of 240 acres of arable land, cultivated on the Norfolk rotation, six crop-men are sufficient; the following is a rough calculation of the work performed by each man, and the cost per acre:—

	£.	s.
Cutting (mowing) 8 acres of wheat, at 7*s*.	2	16
Mowing 10 acres of barley, at 2*s*.	1	0
Pitching and loading 10 acres of wheat, at 1*s*. . .	0	10
" " 10 acres of barley, at 1*s*. 6*d*. .	0	15
Turning barley	0	3
Twice hoeing 1 acre of turnips, at 6*s*.	0	6
	£5	10

Where beans are grown, the cost of cutting and tying is about 6*s*.; the cost of making peas is from 4*s*. to 5*s*. an acre.

6. *Hoeing* the many crops that are benefited by the free use of the hoe, offers frequent opportunity for the employment of the labourer by measure-work. Turnip-hoeing will first come under our notice. The average price we pay for the first hoeing, or sin-

gling out drilled turnips, is 3*s*. per acre; that of the second hoeing, 2*s*. 6*d*.: but when the seed is broadcast, or the distance from drill to drill but small, the cost of singling out will be more. Though turnips planted on the ridge-system are at a greater distance than those drilled on the flat, yet we find, from the necessity there is of pulling the ridges down with the hoe, that the cost is quite as much. In hoeing between the drills of turnips, when the land is soft, the Dutch or thrust hoe may be used at a cost of about 1*s*. 6*d*. per acre, where the distance between the drills is 18 inches. Turnip-hoeing is best done by men accustomed to the work, with whom a bargain is made for the completion of the work in a proper manner; the first and second (and third, if wanted) may be done on our land by the same party, at a cost of from 5*s*. to 6*s*. an acre.

Beet-hoeing is paid at about the same rate as hoeing turnips, viz., from 5*s*. to 6*s*. an acre, for twice going over: a third hoeing is often required, at a cost of 2*s*. 6*d*. an acre. More than half an acre of the first hoeing or singling of turnips and beet is generally performed by a man in a day of ten hours and a half; though, as the labour is not very severe, women and men unable to do very hard work are frequently employed. The turnip-hoer may derive much assistance from his children, by having a small boy or girl to follow him and single the plants which have been left double by the hoe.

Hoeing Carrots.—Carrots are extensively grown in the sandy soils of Norfolk and Suffolk, and no doubt would be grown much more if it were not for the enormous expense in the labour of hoeing and weeding; this might in some degree be lessened, if the drill system of growing carrots were adopted in preference to sowing the seed broadcast. The cultivation of carrots generally gives employment to the undertaker and his gang, who is usually paid for his services by half the crop, or at the rate of 2*d*. a bushel: for this he finds and sows the seed, does all the weeding, hoeing, and takes up and stores away the crop. In fact, he does everything, with the exception of tillage and carting. The number of bushels is ascertained by the number of cartloads carried away. However, when carrots are drilled, the cost of hoeing will be considerably less; I have known the price for twice hoeing (which includes singling out) drilled carrots at 10 inches to be no more than 10*s*. an acre.

Hoeing Wheat.—From 2*s*. to 3*s*. per acre are here paid for hoeing between the drills of wheat. A man accustomed to hoeing will get over three-quarters of an acre in a day: and, as an instance of this, it took two men exactly four days each to hoe 6 acres on a gravelly soil, the drills being about 7 inches apart; they were paid 2*s*. 6*d*. per acre. A bargain is sometimes made for leaving

the wheat-crop clean up to a specified time, usually to the end of June: in that case the wheat receives as many hoeings as it may require, at an average charge of 6*s.* an acre.

Hoeing Beans, Peas, and *Tares* is done for about 2*s.* 6*d.* an acre: a certain difference in the rate of payment is occasioned by the width between the drills; when this is narrow the work goes off proportionally slower. With us barley is seldom hoed, though oats occasionally are, and if so at the same price as wheat.

7. *Harvesting Root-Crops.*—The labourers, in doing this kind of work, may be paid by the acre, or, when the crop is carried off the land, by the number of cart-loads: the former method is to be preferred, as it affords a mode of measurement less liable to dispute. Men with large families are the best to engage in the taking up and storing away roots, as their wives and children will be able to do a good portion of the labour. Harvesting roots is performed in various ways; I shall merely mention those plans most generally used. When the swedes are laid in small clamps of about 40 bushels on the land where they grow, the roots are pulled up and thrown into long heaps, the leaves being first cut or pulled off; the heaps are then covered, first with straw and then with earth. Seven shillings per acre will be a fair remuneration for the labour required in pulling and storing a good crop of swedes in this manner. Should the roots be both topped and tailed, a higher price must be given. Another way of keeping swedes or white turnips is to cover the roots with the plough; the turnips are pulled and laid in a furrow opened by the ploughman, who with another furrow covers the roots with soil, leaving the tops above the surface: the cost of pulling and laying in the turnips will be about 3*s.* an acre; but it must of course be done by children, with a man as overlooker. Pulling, cutting off the tops, and filling turnips into carts, will cost about 8*s.* per acre, but this must depend upon the size of the roots, where the bulk of the crop is the same.

Harvesting Beet.—The pulling and laying the roots in heaps ready to be carted away, the leaves being twisted off by the hand at the time of pulling (which is done by men, and is rather severe labour) is paid for at an average price of 5*s.* an acre for a fair crop; at this rate a man will earn 2*s.* a day, for it will take about 2½ days to pull an acre. As the task-men pull the roots they are filled by boys and carried to the places where they are stored for the winter. With us the filling is done by day-work, at a cost of about 2*s.* an acre: four boys, at 1*s.* a day, filled 190 loads (30 bushels) off 7 acres of land in three days. The beet was pulled in the same time by six men, at the rate of 6*s.* an acre. Banking Beet is the covering the heaps in which the roots are stored with moulds to keep out the frost; the heap is

made about 4 or 5 feet in height, sloping like the roof of a house. A man will cover about 2 rods in length in a day; the rate per rod may be from 10*d.* to 12*d.* In a hard gravelly soil it took six men three days to earth up a heap 30 rods in length; at 1*s.* a rod they would have earned exactly their day-wages at 20*d.* a day.

Taking up and Storing Carrots.—When carrots are sown broadcast and the plants left thick, the cost of taking up and cutting off the tops is sometimes as high as 18*s.* or 20*s.* per acre for a fair crop; but when drilled the cost for taking up is much reduced; this is caused by the carrots being handier to fork up when in rows, besides which they are generally singled out at greater intervals, and are consequently fewer in number and larger than those broadcast. We shall find that if the work is done by day-labourers it will take six men to fork up an acre of drilled carrots; I know this to be about an average, from having assisted in this as well as in other kinds of works that I have described. It will take six boys or girls to cut the tops off as the carrots are taken up by the men. If we take the men at 20*d.* a day, and the children at 6*d.*, we may calculate the cost of an acre will be 13*s.*; by piece-work it could be very well done for 12*s.* an acre. If the carrots are a thin plant, the price will be proportionably lower; and if a very thick one, it may be 2*s.* or 3*s.* above the sum I have stated. It must be borne in mind that this only includes taking up and topping; I have already given (under the head of hoeing) the details of a practice pursued by many carrot-growers in the west of Suffolk.

8. *Dibbling.*—In the eastern counties dibbling is much practised; and during seed-time the dropping gives employment to great numbers of children. Dibbling wheat is done in two ways —one called whole setting, when two rows of holes are placed on a broad furrow slice, the rows being about 5 inches apart: a man will dibble, on an average, half an acre a day, and will find work for three droppers; the cost for dibbling and dropping is from 7*s.* 6*d.* to 8*s.* an acre. The other is called three-quarter setting; one row is placed on a narrow furrow slice, the holes being rather closer together in the row: a man will dibble nearly an acre in a day; this costs about 5*s.* an acre. Beans and peas, being dibbled at wide intervals, 4*s.* an acre are a fair price for them.

9. *Haulming* is the cutting or raking into heaps the stubble left by the reapers; the price varies with the bulk and toughness of the straw. A man paid by the acre will haulm, on an average, upwards of an acre in a day; the price is about 20*d.*

10. *Paring and Burning* uncultivated land is generally done by piece-work; the price is affected by the soil, the prevalence of stones and roots, and by the toughness of the sward. Paring is severe labour, the burning also requires strict attendance both

day and night; in consequence of this, men will not do this work unless they are able to earn a good deal above day-wages; the usual price is from 25*s.* to 30*s.* per acre. Cutting furze, should any grow on the land, is an extra charge: some men are able to pare a quarter of an acre in a day; but there is a great difference in the quantity done in a given time.

11. *Ploughing and other Labour done by the aid of Horses or Oxen.*—In some places this description of work is paid for by the acre, more particularly where oxen are used. In Norfolk the ploughing is sometimes done at the rate of 14*d.* or 15*d.* per acre: the ploughman works two pairs of oxen; by keeping at it all day he is able to get over nearly 2 acres. However, I think the paying for ploughing, harrowing, or any other team-work with the farmer's own cattle, is inferior to the usual practice of hiring ploughmen by the year, or paying them by the day; for in general the greater number of labourers who work with the teams are young men who, if they were employed by the piece, would have too much inducement to slight their labour and overwork their cattle. Besides which, the labour of the teams is constantly changing from one kind of work to another; this arises from the uncertainty of the weather, as well as from other causes, and there would consequently be much difficulty in keeping a correct account of the labour. Ploughing is occasionally done by the jobbing farmer at from 7*s.* to 8*s.* an acre; this includes a pair of horses, plough, and man.

Drill-workers are men who gain a living by letting out drills to the farmers, at a certain price per acre, or by the day's work; the charge for a corn-drill, with man to follow, is from 12*d.* to 15*d.* an acre; for a corn-drill or seed and manure drill 18*d.* an acre are the usual charge.

12. *Digging and Trenching.*—Digging one spit deep (from 9 to 12 inches) usually costs 2*d.* or 2½*d.* the square rod; the quantity dug will vary with the nature of the soil from 8 to 12 rods in a day. In 1835, when day-wages were but 16*d.*, it took four men eight days to dig, in a workmanlike manner, 2 acres of a clayey loam—each man's work averaged 10 rods a day; they were paid 2*d.* a rod.

Trenching two spits, or 18 inches deep, and loosening the bottom of the trench, costs about 6*d.* the rod; a man will, on an average, trench 4 rods in a day.

Digging in seed turnips; for small roots the ground does not require digging very deep; for laying in and covering the roots we have usually paid 3*d.* a square rod. To make myself generally understood I shall describe the operation:—The turnips are laid in a straight trench formed by the spade; two diggings across them intervene between the first and next row of plants.

On a sandy soil that digs well, I find that a man, with a boy or woman to lay the turnips in the trench, will get over 10 rods in a day; at 3*d.* a rod they earned 2*s.* 6*d.* a day. When the turnips are large, the work will of course go off slower.

14. *Thatching.*—In measuring thatcher's work, the practice for a round stack is to take the height in feet from the eaves to the top, and half the girth at the eaves; these, multiplied together, will give the dimensions in feet, which may easily be reduced into squares or yards. For a long stack we measure the length and the height of both sides of the roof; but when the stack is hipped, we either allow 2 yards extra in the length or measure one in addition to the side: the former method is adopted when the dimensions are calculated in square yards; the latter when the square of 100 feet is used. The price for thatching corn and hay stacks is 1*d.* a yard, or from 10*d.* to 12*d.* the square. I am informed by an experienced thatcher that, with the help of a strong lad, he is able to thatch, in a workmanlike manner, 100 square yards in a day, and thus earns 8*s.*; but to do this he is obliged to work early and late, and leaves the finishing up of his stacks till the busy time of harvest is over. In Hertfordshire, and other places where the thatching is done in a superior style, the charge is nearly double that paid in Suffolk.

2. *Task-work to which Lineal Measure is applicable.*

Table of Lineal Measure.

12	inches . . .	make	1 foot.
3	feet . . .	„	1 yard.
$5\frac{1}{2}$	yards . . .	„	1 rod.
40	rods or 10 chains .	„	1 furlong.
8	furlongs or 1760 yards .	„	1 mile.

Under this head are included those descriptions of task-work which are usually paid for at a certain rate per chain, rod, or yard in length; and it applies more especially to ditching, fencing, and draining.

1. *Digging Ditches and Fencing.*—All operations done with the spade depend in a great measure upon the nature of the soil, as to the quantity removed in a given time. Some—as peat—are dug without much labour; while other soils cannot be dug at all unless they are first loosened with the pick. It has been calculated that a man will dig and move 10 cubic yards of soil in a day, the soil not requiring the pick to be used; this is perhaps under the average; for I find the labourers on the railway are paid 2*d.* a cubic yard for moving and digging a hard stony soil to the depth of 18 inches; of this they are able to move from 10 to 12 yards in a day.

As I am aware of the uncertainty of this kind of labour, I shall merely mention the prices and details relating to agreements for the execution of this work.—1. Paid 20*d.* a rod for digging an open drain in a peaty soil; the drain was 5 feet deep and averaged 6 feet in width: a cubic yard was therefore dug for about 1*d.*, or, if we calculate it exactly, 18⅓ yards for 20*d.*—2. Paid 16*d.* a rod for digging a ditch 3 feet deep, 4½ feet wide at top, and 1½ at bottom; the ditch ran through a variety of soils, principally clay and gravel; this bargain also included, in addition to the digging, the laying in a quick for a fence, and the topping the bank with thorns as a protection to the young hedge; 5½ cubic yards of earth had to be moved for every rod; and it took 70 days of labour for one man to complete the job of 114 rods, the amount for which, at 16*d.* a rod, is 7*l.* 12*s.*, or about 2*s.* 2*d.* a day.—3. Paid 1*s.* 10*d.* a rod for a ditch and fence in a clay and gravelly soil; the ditch was 4 feet deep, and averaged a little over 4 feet in width, so that nearly 10 cubic yards of soil were removed for every rod.

2. *Draining.*—The cost of the labour required in draining depends firstly upon the nature of the soil in which the drains are dug, and secondly upon the depth and materials used for filling up. Draining on a *sound clay* free from stones may be executed at a *cheaper* rate per rod in length than on almost any other kind of soil; as from the firmness of the clay the work may be done with narrow spades, and but a small quantity of soil requires to be removed by manual labour. The draining wet sands or gravels or clays in which veins of sand abound, is more expensive than on the sound clays, because a broader spade has to be used, and consequently a larger amount of soil removed. Some soils are so hard and stony that they cannot be dug unless the pick is first used; this adds considerably to the expense. On the sound clays of Suffolk and Essex the price for digging drains, and laying in stubble, heath, brushwood, peat, or whatever else is used, and filling up the drains so far as cannot be done with the plough, is about 4*s.* or 4*s.* 6*d.* the score rods, and 6*d.* for each eye. These drains are made about 30 inches deep; the first spit is ploughed out, the two next dug with narrow draining spades; half a score rods of this kind of draining is reckoned a fair day's work. Sometimes, however, half a score is above an average, for I know a case on a hard clay, lying just above the chalk, which was so tenacious that the men could hardly dig and fill in 6 rods in a day. The cost of digging, laying in tiles, and filling drains 4 feet deep on a clay soil intersected with veins of sand may cost about 6*d.* a rod. We have just completed digging a drain in a meadow, of an average depth of 3 feet, the first 6 inches turned up by the plough. It took thirty days' labour for

one man at 20*d.* a day to dig 101 rods of drain, one man a day and three-quarters to lay in the tiles (tops and bottoms), and about eight days to fill up the drain; making a total cost of nearly 8*d.* a rod. The soil was very wet, stony, and hard. On a loamy soil drained to the depth of 4 feet with a clay subsoil, the upper 10 inches ploughed out, one man would on an average dig 3½ rods per day —throwing out about 10 cubic yards of soil—would lay in about 60 rods of soles and tiles in a day, and fill in 13 rods in a day.

3. *Fencing.*—All kinds of hedging, and the labour required in keeping live and dead fences in repair, and the pulling down old fences, readily admit of payment for task-work by lineal admeasurement. In the management of old fences, one of the practices in this part of the country is to cut down the old thorns even with the surface, and then to make good the loose soil which has washed away from the roots. The price per rod varies with the age and thickness of the hedge, and with the quantity of soil required to make good the bank;—from 6*d.* to 8*d.* a rod is usually paid, this includes topping the bank with the old thorns as a dead fence. Three or three and a half rods will be an average day's work; from 20*d.* to 22*d.* a day may be reckoned fair wages for hedging work; as in addition to his wages the hedger has all the small and decayed pieces of firewood. Breasting over hedges will cost from 3*d.* to 4*d.* a rod, but the price depends entirely upon the size of the hedge. Trimming hedges, or the cutting off the young shoots, with a light hook may be done for a ½*d.* or ¾*d.* a rod; if shears are used, the cost will be rather more. Where fagots are made, they are paid for by the score; 6*d.* a score is paid for the most general size, but the price of course varies a little with the size and length.

3. *Task-work to which Solid or Cubic Measure is applicable.*

Cubic Measure.

	1728	cubic inches . .	make	1 cubic foot.
	27	cubic feet . . .	„	1 cubic yard.
	2218	cubic inches . .	„	1 bushel.
A fraction over	21	bushels . .	„	1 cubic yard.

This applies to the moving of soil, the filling into carts of manure, clay, marl, or any other soil, the turning of compost and manure heaps; it may also be used in measuring the quantity of peat ashes and burnt clay, should the labour of these operations be done by task-work. Though such work as digging ditches and draining is put out by lineal measure, yet we ought to calculate the quantity of soil to be dug in a given length, and by that means have something to guide us in fixing the price.

1. *Filling, Raising, Carting, and Spreading* clay, marl, or chalk

are frequently let out by the job to men who, at a certain price per yard, agree to find horses, carts, and men, and food for the horses, with the exception that the employer allows grass and straw-chaff. The number of cubic yards carted is ascertained by taking the dimensions of the pit or heap from which the soil has been removed, so that there is no means of deception or occasion for disagreement. The price per yard for carting 1 furlong, is for clay 7*d.*; a penny is added for every additional furlong; so that if the distance was 2 furlongs, 8*d.*, if three, 9*d.*, would be charged per yard. The work is usually done with small carts drawn by strong ponies; these appear much better suited to the removing heavy soil than the large carts and long teams which the farmer generally uses in this part of the country. I was told by an old man who has followed the business of clay and marl carter the greater part of his life, that on one occasion he had an opportunity of putting to the test the comparative merits of large and small carts. That when working in the same pit with another party of clay-fillers using large tumbrils or carts, his company of three men filling into small carts drawn by five ponies, were able to accomplish as much as four men filling into large carts drawn by seven powerful horses; the distance and other points being equal. He also informed me that in a week of fine weather he has carted 300 cubic yards of clay filled by three men working 8½ hours a day; or 16⅔ yards of filling and picking down daily.

On our farm at the first beginning or sinking of a pit 140 yards of clay were filled by two men working 7½ hours a day during 15 days, giving an average for one man of more than 9 yards. After the pit was sunk to about 8 feet deep, the two men filling and picking down averaged 10 yards each.* The spreading was done by the men and the boys who drove, working about an hour after they had finished carting for the day. The clay was carted in four small carts drawn by four ponies, with another to assist in pulling out of the pit; the distance of carting averaged 2 furlongs, and in this manner 480 yards of clay were filled, carted, and spread at a cost of 8½*d.* a yard on about 12 acres of land. The labour of filling and spreading clay from a pit by the farmer's own labourers would be as well paid for by measuring the number of cubic yards removed; but this plan is seldom practised, the men being paid by the number of cart-loads, each containing by rough calculation a cubic yard, or the carts may be filled up to a mark made in the sides. The carter who works by the day keeps an account of the number of loads filled by the men in the pit, and as he is not interested he will in

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* I find the quantity of clay filled in a given time is below an average: this arose from wet weather and its being a bad kind of clay to fill.

all probability keep a correct one; but as the same number of heaps of clay are made of each load, it will be an easy matter for the farmer to number the heaps, and thus check any dishonest practices. About 2*d.* the cubic yard or load is paid for filling clay; if many stones are picked out, the men receive 1*s.* for each load. The time of filling is about 8 hours in summer and 7 in winter, the remainder of the day being employed in getting down clay for filling the next day. A man will on an average fill 10 loads of clay besides stones; as an instance it took 45 days for one man to fill 463 loads of clay, besides 13 loads of stones; or rather over 10 loads a day. The clay at 2*d.* and stones at 1*s.* will amount to 4*l.* 10*s.*, or about 2*s.* a day, which may be considered fair earnings. Clay laid in a large heap after being drawn from the pit is perhaps a slower operation than when first raised, for I find men only fill 10 yards each a day. A bargain is sometimes made for filling and spreading clay at from 2½*d.* to 3*d.* a load. Barrowing by manual labour must not be omitted in this account of measure work, for earth may be moved in this manner, for a short distance, cheaper than it can be moved by the aid of horses; and even for claying or chalking small fields of 5 or 6 acres, barrowing would be perhaps cheaper than carting. It has been calculated that in sandy ground three men will be required to remove 30 cubic yards in a day to a distance of 20 yards, two filling and one wheeling; but to remove the same quantity in a day to any greater distance, an additional man will be required for every 20 yards of wheeling. The following is a system of barrowing by manual labour sometimes adopted in those places where chalk lies at a considerable depth below the surface:—A shaft is dug down to the chalk; when this is deep enough, the chalk is dug, and pulled up by a rope and windlass at the top; it is then barrowed on the land. The price for barrowing on a piece of land of about 4 acres round about the shaft is 6*d.* a load of 22½ bushels. This includes both raising and barrowing.

2. *Filling Farm-yard Dung.*—This is done at the rate of 2*s.* a score loads of about 1⅓ cubic yards each; spreading will be about 1*s.* 6*d.* or 2*s.* for the same quantity.

3. *Turning over Manure Heaps.*—When the heap consists entirely of farm-yard manure, the labour of turning over is more quickly performed than when the heap is partly composed of heavy soil. There are also two ways of performing this operation, by one of which the work is got over faster than by the other, though the slowest way is greatly to be preferred if the farmer's object is to mix the different substances of which the manure-heap is composed. One of the practices is the mere reversing the manure by trenching it over; while in the other the labourer begins at the side, and picks down the manure from top to bottom

mixing it well as he proceeds, he then throws this up with a fork, and goes on alternately picking and throwing up. The general and perhaps the best way of paying for the labour of turning over manure-heaps is by giving a certain sum for each heap; we usually pay from 8*s.* to 12*s.*, but this of course varies with the size of the heap, and the nature of the substances of which it is composed. A fair price may be calculated by taking the dimensions in cubic yards; it will cost but a few minutes to make a measurement. Or sometimes the farmer keeps an account of the number of loads carted on the heap, and by that means fixes a price at so much per score loads of about 1½ cubic yards each. For turning over farm-yard manure 1*s.* per score; and for picking down and turning over heaps composed of earth and manure, 2*s.* per score loads are paid.

4. *Burning Peat-ashes* is an uncertain employment for the labourer; the quantity of ashes depending in a great measure upon the weather for drying the peat. The customary payment for burning peat-ashes is about 5*l.* per 1000 bushels, reckoning 25 bushels to a cubic yard. I think, however, payment by the cubic yard is quite as correct a way of ascertaining the true quantity. The season for burning being at an end, the ashes are laid (previously to thatching) in a rectangular heap of 15 feet average width, 3 feet in depth, and to any convenient length; the length, breadth, and depth being multiplied into each other, and then divided by 27, we shall thus have the number of cubic yards. The price paid by us per yard is from 2*s.* to 2*s.* 4*d.*; in an average season of 20 weeks (harvest included) a man and his wife burnt 200 cubic yards, which at 2*s.* a yard gave them 1*l.* a week.

4. *Task-work to which the Corn Measure is applicable.*

TABLE OF CORN MEASURE.

4 pecks . . .	make	1 bushel.
4 bushels . . .	„	1 coomb.
8 bushels . . .	„	1 quarter.

Corn-measure applies to threshing corn by the flail—a practice which will, it is hoped, be soon superseded by threshing-machines. However, as a large portion of grain is still threshed by manual labour, I cannot but give it a place in my description of piece-work. The quantity of corn threshed in a given time either by the flail or by machines will depend upon a variety of circumstances; the kind of soil upon which the grain grew, the season, and the condition when harvested, will all affect the quantity threshed in a given time. In our neighbourhood (Suffolk) but a small proportion of the farmers have threshing-machines of their own; but there are men who get their living by letting out port-

able machines at a certain price per day; these are generally worked by four horses; the charge for a machine with a man to tend is 12*s.* a day, besides the expense of moving the machine and boarding the man. On an average these will thresh from 20 to 30 quarters of wheat (reaped), from 15 to 25 of mown wheat, and about the same quantity of barley as of mown wheat in a day. The annoyance of shifting the machine, with the loss of time to the horses and men, renders the practice of hiring by the day both inconvenient and expensive. However, as many large farmers are beginning to have horse-power machines, it is to be hoped that we shall soon see the good example of threshing by steam-power which has been set by the northern farmers, followed by their brethren of the east.

1. *Threshing Wheat* by the flail is much practised by the farmers who supply the London market with straw, the generality of machines being found to break the straw. In Suffolk the price for threshing and dressing reaped wheat costs from 2*s.* 6*d.* to 3*s.* a quarter—should the wheat yield well, a man will thresh out a quarter in a day. With the common hand-dressing machines 15 quarters may be twice winnowed and put into sacks by two men in a day.

2. *Threshing Barley.*—With us a much larger proportion of barley is threshed by hand than of wheat, for it is often done as cheap by hand as it is by our present system of hiring machines. Allowing one of these to thresh 20 quarters of barley in a day of 10 hours, the following will be a rough calculation of the cost:—

	s.	*d.*
Hire of machine . . .	12	0
Board of man . . .	1	0
Six horses	15	0
Six men at 20*d.* . . .	10	0
Four boys at 8*d.* . . .	2	8
Dressing 20 quarters at 2*d.* .	3	4
Total . .	44	0

The average expense of threshing and dressing 40 quarters of barley of the same description is 40*s.*, or 4*s.* cheaper than the machine, which will nevertheless have the advantage of despatch. The rate per quarter for threshing and dressing varies from 1*s.* 6*d.* to 2*s.* a quarter. I have known two men to thresh and dress on an average 15 quarters a week; at 20*d.* a quarter they earned 25*s.* weekly. When barley is harvested in large barns 2*d.* or 3*d.* a quarter is given extra, for that laid in the middlestead or threshing-floor.

3. *Oats* are threshed for 1*s*. to 1*s*. 4*d*. a quarter; beans and peas from 1*s*. to 1*s*. 6*d*. The quantity threshed varies from $1\frac{1}{2}$ to 2 quarters per day.

4. *Clover and other Seeds.*—The price paid for cobbing (separating the seed from the straw) and drawing the seed of red and white clover is from 3*s*. 6*d*. to 4*s*. 6*d*. the bushel of 5 stone of seed. Drawing seed by the flail is a tedious and expensive process, and is much better performed by mills constructed on purpose for the work. From 1*s*. to 1*s*. 4*d*. is paid per quarter for cobbing trefoil; the drawing is usually done by mills.

5. *Task-work performed by various kinds of Measurement.*

1. *Trussing Hay* for the London market is chiefly done by men who make a business of it, and by practice become exceedingly expert. In Hertfordshire the price for trussing and weighing ready for market is 1*d*. a truss; a good hand, with the assistance of a boy, will in summer make 100 trusses in a long day. In Suffolk the hay-trusser is neither so skilful nor so well remunerated; the charge for trussing is about $\frac{1}{2}$*d*. a truss, or from 1*s*. 6*d*. to 2*s*. a ton.

2. *Picking Stones* is paid for by the load of 20 bushels, at about 10*d*. a load. A woman will generally manage to pick a load in a day.

3. *Riving Wood* is done by the stack, at 3*s*. 6*d*. for long lengths suited for kiln burning, and at 5*s*. for short lengths.

4. *Shearing Sheep* is done by men who form themselves into a company, and engage to shear the sheep belonging to the surrounding flock-masters. The following are the prices for Down and Leicester sheep:—Ewes, 3*s*. 6*d*. a score, of which one man will on an average shear twenty-five in a day of 12 hours' labour; hoggets or yearlings, 4*s*. 6*d*., of which a man will shear twenty; large fat sheep and rams, 5*s*. a score. Sometimes the employer agrees to board the shearers, he then pays 3*s*. a score for hoggets, and 2*s*. for ewes.

5. In *Hiring Shepherds* an agreement is sometimes entered into, by which they receive, in addition to their weekly wages of 10*s* to 12*s*., about 6*d*. for each lamb brought up, and out of this money to be received pay 9*d*. for every sheep that dies.

6. There are other kinds of agricultural labour which admit of being paid for by measure-work which have not been mentioned; among these are burning lime, cutting chaff, planting cabbages and potatoes; taking up potatoes; the latter operation may be done at so much per sack; we found 3*d*. to be a fair price, or they may be taken up at a certain rate per acre.

Table of the Value of Labour in Suffolk.

Wages of a common day-labourer, 10*s.* a week; at harvest-time, about 3*s.* 6*d.* a day.

	s.	*d.*		*s.*	*d.*	
Mowing wheat	6	0	to	8	0	per acre.
,, barley	2	0	—	2	6	,,
,, grass	2	0	—	2	6	,,
,, clover and rye-grass .	2	0				,,
Reaping wheat	8	0	—	10	0	,,
,, beans	6	0				,,
Pitching and loading wheat .	1	0				,,
,, ,, barley . .	1	6				,,
Hoeing, singling out turnips .	3	0	—	3	6	,,
,, second time . .	2	6	—	3	0	,,
,, between drills . .	1	6				,,
,, drilled carrots, three times.	10	0	—	15	0	,,
,, wheat	2	6	—	3	0	,,
,, tares, beans, or peas .	2	6	—	3	0	,,
Pulling and storing swedes in clamps	7	0				,,
Laying in turnips . . .	3	0				,,
Topping and tailing and filling turnips into carts . . .	8	0				,,
Pulling mangold-wurzel . .	5	0				,,
Filling into carts . . .	2	0				,,
Taking up and topping carrots broadcast	18	0	—	20	0	,,
Ditto drilled	12	0				,,
Dibbling wheat, whole setting .	7	6	—	8	0	,,
,, ,, three-quarter setting	5	0				,,
,, beans and peas . .	4	0				,,
Haulming	1	8				,,
Paring and burning . . .	25	0	—	30	0	,,
Ploughing	1	4				,,
Harrowing and rolling, each about .	0	2				,,
Digging	0	2	—	0	2½	a rod square.
Trenching	0	6				,,
Digging in small turnips for seed .	0	3				,,
Thatching stacks . . .	0	1				a yard.
Digging ditches (various)						
Common Suffolk draining, 30 inches deep	4	0	—	4	6	a score rods.
Tile-draining, 4 feet deep . .	0	6	—	0	8	a rod.
Cutting down hedge, facing bank, and putting on dead fence. .	0	6	—	0	8	,,
Filling clay	0	2				per yard cube.
Ditto and spreading clay . .	0	2½	—	0	3	,,
Filling muck	2	0				score loads.
Spreading ditto . . .	1	6	—	2	0	,,

	s.	d.		s.	d.	
Turning muck-heaps . .	8	0	—	12	0	each.
Turning over farm-yard dung .	1	0				score loads.
Picking down and turning over compost-heaps . . .	2	0				"
Threshing wheat . . .	2	6	—	3	0	a quarter.
" barley . . .	1	6	—	2	0	"
" oats . . .	1	0	—	1	4	"
" beans and peas . .	1	0	—	1	6	"
Trussing hay	1	6	—	2	0	a ton.
Picking stones . . .	0	10	—	1	0	a load.
Riving wood	3	6	—	5	0	a stack.
Shearing sheep—ewes . .	3	6				a score.
" hoggets . .	4	6				"
" fat sheep & rams	5	0				"

Note by Lord Portman.

There are two points in the ordinary management of task-work which require, I think, some further consideration. I mean the practice of leaving the price of a job to be fixed at its conclusion, and of drenching the men with liquor to superinduce undue exertion. I have found that measure-work, if it be well regulated, is an admirable system; but that the greatest evil results from a delay in fixing the price of the job. I am aware that it is often impossible for the master or the man to make a bargain until one day of trial has been fairly made; and I am aware that sometimes accidental circumstances are developed during the progress of the work which may render the best considered bargains unfair, and therefore not to be insisted upon;—but as a general rule the price should be fixed before the work is begun for any measure-work, in which both parties have had sufficient experience to guide them; and on the second day after it is begun, when either party requires a trial to guide him in fixing the price. The questions for the master to determine are—What is the job worth to me?—What will it cost me at day-work?—What additional cost is it worth if it is finished in a shorter time than men at day-work will complete it in? The questions for the labourer are—How much can I earn in a day at day-work?—How much at this job, with my usual exertion?—How much can I better my income by some extra time, and some greater exertion, if I take this job?

Turnip-hoeing, reaping, mowing, threshing, turning manure-heaps, &c., admit of some standard of value on every farm; but each job requires to be viewed before the actual price is fixed to regulate any variation from the standard that accidents in each year may create. Moving earth, chalking, digging ditches, &c.,

require an opening of the land to enable either party to estimate the price. The too frequent practice is to say, "Go on, and I will do what is right when we settle." The consequence is generally a squabble on the day of reckoning, for the men expect more than the job is worth, because they have spent so much time over it; and the master offers a little more than the wages of men at day-work, because he will not trouble himself to value the actual job. The fair price is in such cases seldom given. The parishioners often refuse a job at a fair price, because they say "they must have work or be kept." The strangers take the same as a fair bargain, and do well. I could mention case after case to illustrate this fact. The spirit of opposition should be firmly and fairly met by proving when it is finished the correctness of the value which had been affixed to the job before it was commenced. It is also essential to estimate the time in which the job can be properly finished; and it should be made a part of the bargain that the job should be completed by a given day, unless the weather prevent it. No other excuse should hinder it, for in the case of illness or other inability the contract should cease at once. It must not be forgotten that no *summary* remedy exists for the enforcing any contracts for measure-work; and that often the labourer who works in a party—of which the foreman alone agrees with the master, and the rest of the men agree with the foreman—is cheated by the foreman, and has no redress for which he can afford to pay. The master should therefore protect the whole of the men by some arrangement as to their individual payment.

The drenching with liquor—beer, ale, or cider—is generally approved by the men, as it excites them for the time, and gives them what they call "a heart to work;" but it is very unwise to adopt it as a practice. I advise that when they can be led to abandon the gratification, a money payment, rather exceeding the value of the liquor, should be made to them, which benefits their families, and enables the men to improve their diet. But at all events, if they cannot be led to abandon the liquor, I should advise the substitution of a supply of meat in lieu of a portion of the liquor, giving thereby strength to the men, and averting the evils of intemperance. Where the men are single or without family, I have found it difficult to lead them to abandon the temporary gratification; but in that case, I would narrow the allowance as much as possible, and give them the remainder that would be due to them in the shape of clothes or tools, for the purpose of proving to them the benefit of my plan. Many masters give liquor as a spur for the momentary exertion to serve their immediate purpose, regardless of the injury done to the men; some give liquor to save their pockets; none, within my know-

ledge, who have tried to lead the men to abandon that mode of receiving payment, have, after experience, resumed the payment in liquor, though many give, as occasion may suggest, a portion of liquor as a reward for well-timed and good-natured zeal.

PORTMAN.

VIII.—*On Burning Clay.* By CHARLES POPPY.

To Mr. Pusey.

SIR,—Having seen a report of your experiment in burning a poor clay soil, I trust you will excuse my informing you that burning clay is continued to be much practised on the cold clay-lands in this county (Suffolk), and is the main source of manure with the labourers on their allotments and gardens; at least they burn all rubbish and clods where permitted, but many owners will not permit their tenants to burn the surface-soil.

Two years since I redrained a very poor piece of land, at nine feet distance, ploughed it up when tolerably dry in the spring, and burned all I could get taken up with three-tined forks, in heaps 30 yards in circumference, on a space of two acres, breaking the clods as they were thrown on the heaps. When burnt, it was carted and spread on the same land, and the quantity proved to be 30 bushels per rod, or 4800 per acre.

The field was fallowed through the summer, and sown with barley and clover last spring twelvemonth. On a part of the field where not burnt, 4 cwt. of guano were sown upon the barley; another unburnt portion was manured with town-muck; and a third portion, also unburnt, was left unmanured. The barley proved equal in bulk where manured with burnt clay, with guano, and with town-muck, the yield being apparently one-third more than where no manure was applied. The present crop of clover where the burnt earth was spread is a very heavy crop, also where the town-manure was laid; but I cannot see that on the portion where the guano was sown on the barley the clover is the least better than where the land was left unmanured.

In another field I burnt ditch and bank earth, and laid them on the land for barley, which proved as much superior to the rest of the field as in the other case; and the beans, as far as the burnt earth was spread, are a foot higher than the rest of the field.

As far as I could judge by the description of the soil you burned, mine was very similar. The weather is so suitable for burning clods, which abound on heavy soils, and the cost merely labour, that I thought it possible you might wish to know the effect of burnt earth in such a severe drought as the present. The

beneficial effects of burnt earth may be seen for many years on poor heavy land.

It is also an unlimited source of employment, and particularly to old men and weak hands, as well as a means of much increasing the produce of some districts.

Yours obediently,
CHAS. POPPY.

Witnesham, Ipswich, June 3rd, 1846.

July 1.—My estimate of the produce of the clover whilst standing on the respective portions of the field described above proved to be correct on cutting and carting. The beans are still by far the most promising crop. This was not a new experiment, except as to quantity of earth burned and spread on the same space from which it was taken. Great quantities of earth are burned for manure every year in this county in the heavy land districts, and such has been the case as far back as the oldest farmers and labourers can remember.—CHAS. POPPY.

IX.—*On the Use of Superphosphate of Lime, produced with Acid and Bones for Manure.* By W. C. SPOONER.

PRIZE ESSAY.

THE difficulties under which the pursuit of agriculture has for some years laboured—the importance and indeed the absolute necessity of raising the largest crops of roots at the least possible expense, afford ample reasons for the Council of the Royal Agricultural Society of England proposing as a subject suitable for a Prize Essay "The Use of Bones with Acid," which on high authority has been designated "the most important saving which was ever held out in the use of manure." If any additional reason were required why the utmost attention should be devoted to this important matter, and the most extended information gained respecting it, it may be found in the fact that while the constantly increasing population of this country demands a corresponding augmentation of animal and vegetable food, the sources of supply both of bones and guano are likely to become greatly diminished. Thus not only as it affects the interest of the occupier and owner of the soil, but also on national grounds, is the subject of our Essay worthy of the deepest consideration. The superior economy of employing bones mixed with an acid, over that of using bones alone, is no longer a hypothetical or even a probable statement, but an established fact; and though I shall have to offer

some results in corroboration, yet I do not hold them as essential to the subject, so fully has the success of the mixture been established by the numerous experiments related in the Journal of the Royal Agricultural Society, and more particularly in the excellent and elaborate Essays of Mr. Hannam. And though I shall find it necessary to pass rapidly over all the various branches of the subject, yet my claims for honorary notice will principally rest on affording such practical information on points hitherto but briefly attended to, as may, I hope, render this Essay of really practical and pecuniary value to agriculturists in general.

The specific effect of bone as food for the turnip-crop has long been known—long indeed before Science was in a position to explain the cause of its peculiar effects, or to assign correctly to what portion of its constituents the benefits are chiefly due.

It was found, greatly to the surprise of many, that burnt bones, in which of course the organic parts had been destroyed, were equal if not superior in their effect to bones not so treated; and that when boiled, in which state the fat had been expelled, they were more productive than bones in a fresh state. It was thence supposed by those who jumped to conclusions too hastily, that the substances thus expelled were useless at any rate for the turnip crop, and they were apparently supported by the theory of a very eminent chemist, who, if we mistake not, laid it down as his opinion that the value of manures depended principally if not entirely on their inorganic ingredients—a doctrine altogether at variance with the previous generally received notions, that ammonia was the true fertilizing element, and that its amount afforded the measure of the value of manure. *In medio tutissimus ibis*—the truth, we take it, will be found to lie between the two extremes. We may justly regard the inorganic constituents as being the most important and essential portion of manure, affording to the plant what the skeleton does to the animal, the basis of support; and as plants can obtain no other supply but through the soil, we may justly regard them as *the* most essential constituents.

The other elements are to a great extent supplied through the atmosphere, and even nitrogen and its combinations may be thus furnished. The avenues through which this atmospheric supply is furnished are the leaves of the plant, and their size afford a correct criterion, *cæteris paribus*, of the amount of nutriment derived from the aerial source. Thus beans and other pulse obtain more food from the atmosphere than cereal plants; roots more than the former; and wheat, from the small size of the leaves, less than any. Thus only can we account for the striking fact that if we give a good supply of inorganic elements *only* to the turnip-crop, we shall very probably have a plentiful crop, whilst if these

be absent, however rich the manure may otherwise be, the crop will be a failure. Not that we must therefore draw the conclusion that the organic manures are of little or no importance to root-crops;—they are of value, and particularly to the grain-crops which succeed.

The organic matter which composes about one-third the substance of bones is, however, so intimately combined with the earthy portion, and their disunion is accomplished with such difficulty, that the good effects of either are to a certain extent neutralized, at least so far as the first crop is considered ; and we are consequently obliged to supply five or six times as much as the crop actually requires, and to render them available by means of pulverization. It is on this principle that the assistance of sulphuric acid is sought for and obtained—it serves by its chemical affinities to separate the component parts of the bones, and render them more soluble and available as food for plants. In the excellent and accurate experiments of Mr. Hannam, related in a former Number of the Journal, it was clearly proved that fresh bones when ground were superior to boiled ones, from which the fat was extracted ; and the latter were superior to burnt bones, from which the gelatine was also removed. This result was, however, far more striking when the bones were dissolved in sulphuric acid, a difference of nearly 2 tons of turnips being observed, whilst with the bones merely ground a difference of 17 cwt. only was exhibited. From the same experiment we likewise learn that the beneficial effects derived from the earthy part of bones are $4\frac{1}{2}$ times greater than that derived from the organic parts. I refer to the Journal for the particulars of these experiments, and to the previous Number for other statements, from which, if we had no other evidence, we should be justified in drawing the conclusion that 20*s*. laid out in bones and acid will go much further than 40*s*. expended in bones alone, so far as the turnip-crop is concerned.

These experiments, however, appear to have been made with the addition of a very considerable quantity of water, so as to apply the manure to the land in a liquid state, which, without denying its superiority, is yet attended with such difficulty, trouble, and inconvenience, that it is vain to expect that farmers generally would incur it. The expense of a proper cart for the application of this manure in a liquid state is very considerable, and sufficient to prevent its general adoption. And although it was in this form that the public were first made acquainted with its valuable properties, yet its general adoption must be attributed to the additional discovery that it can readily be applied in the state of compost by means of the common drill. Having directed my attention to the preparation and employment of this valuable manure in the form

of compost, I am in a position to state that by its means one-half the usual expense in the purchase of bones may be saved.

We cannot, however, do better than take as our text, or rather the heads of our subject, the points to which the attention of competitors are drawn by the Council of the Royal Agricultural Society, which are—

1. State of Bones.
2. Proportion of Acid in a given weight of Bones.
3. Proportion of Water, if any, mixed with the Acid.
4. Mode of mixing the Bones with the Acid, and of preparing the Compost.
5. Effect of various quantities applied in combination or comparison with common Bones and other known Manures.

1. First, then, the state of the bones—with regard to which I have merely to observe that they should be as fine as possible, but the ordinary state of bone-dust will answer the purpose very well. The dust is decidedly preferable to half-inch bones, for whilst the increased weight of the former will compensate for its greater price, the points of contact being greatly increased by subdivision, the bones are more rapidly and more perfectly acted on by the acid, and require in fact a less quantity both of that and of water.

We next come to the second and more important point.

2. The proportion of sulphuric or muriatic acid to a given weight of bones.

Sulphuric acid is preferable to muriatic acid for several reasons —it is stronger, cheaper, has greater specific gravity, and contains much less water. On mixing it with water a much higher temperature is attained, which conduces to the dissolving process, particularly of the organic portion of the bones. In addition to these reasons, we find that in the trials which have been made muriatic acid has been found somewhat inferior. I have, however, been rather surprised that there should not have been a more decided difference than proved to be the case in Mr. Hannam's experiments; and we can only account for this by bearing in mind that the lowest proportion of muriatic acid employed was one-half, which was perhaps sufficient to affect all the phosphate of lime contained in the bones, whereas if one-third had been employed, as was tried with the sulphuric acid, the result might not have been so favourable for the muriatic acid. Besides this, probably the muriate of lime formed by the muriatic acid is more fertilizing and soluble than sulphate of lime formed by the sulphuric acid, and, from its great attraction for moisture, particularly advantageous in such a dry season as that of 1844. It is therefore by no means improbable that an equal quantity of

bones prepared separately with the two acids, and afterwards mixed together, might be more productive than bones prepared with either acid alone.

The proportion of sulphuric acid most desirable to employ is a very important point, inasmuch as it has been shown that sulphuric acid alone, or mixed with water, possesses very little fertilizing powers. This probably is owing to the circumstance of the soil generally containing a sufficiency of this element, and to the fact that phosphoric acid is so extremely essential, particularly in the early stages of the growth of the plant, that it will not prosper without it, whatever we may otherwise employ as manure. A neighbouring agriculturist during the last year tried to raise a crop of turnips with a good dressing of salt and soot, which contain no phosphoric acid though plenty of ammonia and other fertilizing ingredients, but the result was a total failure. In a garden experiment, I may here observe, I found sulphuric acid and water succeed as well as bones in raising turnips, but the soil no doubt contained phosphoric acid, as well as alkalis, on which the acid could act favourably.

Before we authoritatively pronounce on the quantity of acid necessary to be mixed with the bones, it will be better to inquire into the nature and properties of the substances we propose mixing together.

Sulphuric acid, or oil of vitriol, as it is more frequently termed, consists of the union of two parts by weight of sulphur with three of oxygen gas, and its strength depends on its purity and freedom from water, for which it has a remarkable affinity, so much so that if exposed to the air it will quickly absorb water from the atmosphere. Its relative weakness, therefore, is owing to the quantity of water mixed with it. In speaking of sulphuric acid, I must be understood to mean the acid in its concentrated state, possessing a specific gravity of from 18·45 to 18·50. And it should be borne in mind, in purchasing the acid, that 50 lbs. of the above is at least equal to 60 lbs. of the specific gravity of 1·714, and therefore if the weaker acid is used, its quantity must be increased in proportion to the diminution of its strength.

On applying the vitriolized bone to the tongue, we find that it tastes both sour and sweet. The sourness arises probably from the phosphoric acid, and the sweetness from the gelatine sugar which is formed by the action of the acid on the gelatine, converting a substance very difficult of decomposition into one readily soluble, and which can be easily absorbed by plants. When concentrated acid is mixed with a quarter of its weight of water, the temperature of the mixture is raised to 300°, and boils away at a great rate. The action of this heat on the animal part of the bones renders it of a dark colour; but if a small quantity of

acid only be employed, the mixture is white, from the carbonate of lime which then predominates. From an average taken from several analyses of bones of man and various animals, the following appears to be tolerably near the mean:—

Organic matter, consisting of gelatine, cartilage, and fat	34
Phosphates of lime and magnesia	59
Carbonate of lime	7
	100

Or, in rough numbers, the organic matter may be regarded as forming one-third, and the earthy portions two-thirds. Of course if the bones are very fresh the former will be in larger proportion than one-third; thus Mr. Hannam gives it as 45 per cent. The above, however, may be considered as a fair average in the state usually employed by farmers.

Four bushels of bones, which may be considered to be a fair allowance for an acre, will weigh in a fine state of bone-dust about 180 lbs.* This quantity contains 12½ lbs. of carbonate of lime, consisting of carbonic acid 5½ parts, and lime 7 parts, which will require 10 lbs. of sulphuric acid to convert it into sulphate of lime or gypsum. This is the first result of the mixture, and is the cause of the very unpleasant fumes which are given off, and which consist in fact principally of carbonic acid disengaged from the carbonate of lime in consequence of the superior affinity which lime has for sulphuric acid. This result takes place before the acid acts on the phosphates of the bones, and thus it is that when a small quantity of acid has been sprinkled over bone-dust the good effect has been but moderate, the carbonate of lime alone has been acted on, and the phosphate of lime has remained undecomposed.

The quantity of phosphate of lime existing in the 4 bushels of bones is about 106 lbs., containing 47 lbs. of lime and 59 lbs. of phosphoric acid. If we consider superphosphate of lime to contain a double portion of acid—a fact, however, not quite decided, then 33 lbs. of sulphuric acid will be required, which by uniting with half the lime, or 23½ lbs., forms gypsum, and leaves the other moiety of lime united with a double portion of phosphoric acid in the state of a superphosphate. Thus 43 lbs. of acid will be required to effect these changes, leaving any additional quantity for other purposes.†

* I find that the *average* weight of bone-dust, as it comes from the mill, is 168 lbs. per 4 bushels, although I *have* found it reach the weight stated in the text.—AUT.

† I do not mean to say that these are the precise changes which take place, but only an approximation to them. Probably some portion of phosphoric acid may be left in a free state in the prepared mixture.

Phosphate of lime is a substance very difficult of solution, and thus in a very dry season the effects of bones are often very slight and imperfect. Superphosphate of lime, on the other hand, is extremely soluble, so much so that the vitriolized bones can be entirely dissolved or suspended in water, and thus applied. This at once explains the cause of the valuable properties of the preparation. The bones in their natural state are extremely indigestible, the acid cooks them—converts them into a species of soup which can readily be eaten and digested by the young turnips. The adamantine fetters with which the various elements composing bones are bound so compactly together, are by means of this new agent burst asunder—the compact is broken, and each constituent element is left to pursue its own course and to exercise its own natural affinities. The chemical changes which take place between the sulphuric acid and the organic portion of the bones are no doubt very complicated. Sugar is one result, and probably sulphate of ammonia is another; but I cannot venture to state what quantity of sulphuric acid may be necessary to effect these changes. If we presume that one-third is the proportion of sulphuric acid employed, then there will remain 17 lbs. to act on the organic portion of the 4 bushels of bones, the remainder having been required by the earthy portion.

We find that manufacturing chemists in the preparation of phosphorus from bones (now largely required for lucifer matches) first destroy the organic part of the bones by means of fire, and then mix the remainder with half its weight of sulphuric acid. Thus if we suppose 180 lbs. to be the quantity employed, by burning it will be reduced to 120 lbs., requiring 60 lbs. of acid to form superphosphate, which would be one-third the weight of the bones previous to burning. I suppose, however, that in this case an excess of acid is required to render the process complete, as one-half would otherwise appear to be more than the quantity demanded.

From these and other reasons we may justly consider that the proportion of acid to the bones should never be less than one-third nor more than one-half. The former, I think, is the most economical, but probably the precise quantity most desirable will be 42 per cent. of acid. I may, however, observe that in an experiment during the last season, in which one portion of the land was manured with bones and acid in different proportions, that which had more bones and less acid proved to be a somewhat better crop than where fewer bones and more acid were used; the expense being the same in both instances.

3. The proportion of water to be mixed with the acid will next receive our attention.

When one part by weight of water is mixed with four of acid

the temperature is raised to 300° Fahr. It is therefore very desirable that sufficient water should be used to produce this great heat, which facilitates the dissolving process; and the quantity above stated or, if more convenient, the same measure of water as of acid, which will be rather more than half the weight, will be a very good proportion. More should not be used, as no useful purpose will be accomplished. In an experiment tried last year with different proportions of water, I could not detect any difference in the result. The water should be applied first by means of a watering-pot, so that it may be intimately combined with every portion of the bones. This is an important point, and greatly facilitates the dissolving process, which without it is very likely to be imperfectly accomplished.

Another reason for applying the water first is, that the bones becoming partially saturated, the acid, from its great affinity for it, rushes as it were into the pores of the bones in search of the water, and thus the bones become more rapidly and perfectly mixed with and acted on by the acid. When no water is employed, and the bones are not entirely in the state of fine dust, as they never are unless purposely sifted, the surfaces of the small pieces of bones become acted on by the acid, and a coat forms around them which seals up the interstices of the bones and prevents the acid from penetrating. I have no doubt this is often the case likewise from careless or imperfect mixture, and the good effects of the manure are thus materially diminished.

4. Mode of mixing the bones with the acid and of preparing the compost.

It has been recommended that a large heap of ashes or mould should be made with a hole or depression on the top, in which the bones are to be placed, the acid poured over them, and after some time the whole shovelled up and mixed together. Now, if we examine into the effects of this mode of procedure, we shall readily perceive the objection to which it is subject. The ashes no doubt contain a considerable portion of carbonate of lime besides other salts, for which sulphuric acid has a very strong affinity. Thus the bones are robbed of a large proportion of the acid, of which they ought to have exclusive possession. And even if common mould is used, or any other substance which has no particular chemical affinity for the acid, still this mould will mechanically absorb much of the acid, and thus deprive the bones of it.* I hold it, therefore, as a point of much importance that

* I have not found that any considerable quantity of the acid passes through the bones into the heap of ashes or earth; and though Mr. Spooner's is the better plan, where his apparatus can be easily procured, I still think that the expedient I mentioned may be found sometimes convenient.—Ph. Pusey.

the whole of the acid should be directly applied to the bones, and that no other substance should be allowed to intercept or abstract their mutual affinities.

A very convenient and cheap vessel for manufacturing the mixture is a sugar hogshead, having its holes stopped with plaster of Paris. It is very desirable to avoid if possible any measuring or weighing of the acid, as it is so very dangerous a substance to handle. Many serious accidents occurred to my knowledge during the last year, and it is very difficult to impress farm servants with a sufficient degree of caution, or even to convince them that a liquid which appears so colourless will burn their skin and clothes. In emptying a carboy of acid even into a tub it is difficult to prevent a little slopping about and damaging the clothes of the attendants, as well as the basket, &c. which contains the carboy. To prevent these unpleasant consequences I have adopted the following plan:—The carboy is placed on a stage or cask the same height as the sugar-hogshead, into which is put the precise quantity of bone-dust we intend mixing with the carboy of acid. The water is now added with a watering-pot having a rose at the end, so as to disperse it thoroughly, and the carboy of acid is then emptied by means of a syphon. This syphon is formed of a piece of block-tin pipe, which can be bent into any form, about $\frac{3}{4}$ of an inch in calibre and 4 feet in length. A brass cock is soldered to the long end of the syphon, on which the rose of a watering-pot may be placed. The syphon is now filled with water, and its long end closed with the cock, and the small end with the hand or finger. The latter is then quickly inserted into the mouth of the carboy, the cock turned on, and the acid will continue to flow till the vessel is nearly empty, without any assistance, so that the attendant has no occasion to expose himself to the injurious and offensive fumes which almost immediately begin to escape. He may, however, approach the windward side of the tub, and give the mixture a little stirring, which should be continued for some little time afterwards, so that the mixture may be complete. A convenient utensil for this purpose is a fork with two grains, long in the grain, bent at some distance from the grains nearly at right angles, and fixed in a wooden handle. On the same day a fresh lot of bones may be added, and the process repeated until the hogshead is nearly full. In two days afterwards the mixture may be shovelled into a heap, and either remain till wanted or mixed at once with a certain portion of ashes. It should be shovelled over several times and ashes added at each time of turning, which will thus render the mixture fine and dry enough to pass through an ordinary drill.

It must be evident that much of the value and economy of the

manure depends on its being perfectly mixed, so that every particle of bone should be exposed to the action of the acid. In many cases I have no doubt this has not been sufficiently attended to, and the result has been either that more acid has been used than is really required, or that much of the advantageous effects has been lost.

By the method which I have here recommended, and which I have adopted after many trials, the mixture can be readily and accurately manufactured, and with perfect safety to the attendants.*

5. Effect of various quantities applied in combination or comparison with common bones and other known manures.

My own experience of the advantages of sulphated bones commenced in the very dry summer of 1844. Wishing to try their effects, and thinking that it was highly desirable to apply them as a compost by means of the drill (though I had not heard of any instances in which they had been so used), I resolved to make the attempt. I intended to apply the bones at the rate of 3½ bushels per acre, and half their weight of acid; but from not making sufficient allowance for the dampness of the manure, it extended over a larger portion of land, so that little more than 2 bushels per acre were used with about 16 bushels of ashes. On the same day (in the early part of July) other portions of the field were drilled with bone-dust at the rate of 16 bushels per acre, and some parts with South American guano. The bones and acid swedes were the first to appear, and their tops grew most luxuriantly. The turnips suffered from not being hoed till they were too forward; but the crop throughout the field (considering the late period of their being drilled, and other unfavourable circumstances) was a very fair one, about 14 tons to the acre. The bones and acid portion was fully equal to the rest, and indeed somewhat better than where 16 bushels of bones had been applied to the acre.

Every alternate ridge was carted off, and the remaining half fed off by old ewes with no other food, with the exception of a little inferior hay. The field was then sown with dredge (a mixture of beans, barley, and peas), and the crop was a very excellent one; that where the vitriolized bones had been used was at the least fully equal to any portion of the field, and indeed somewhat superior to that dressed with bones alone. Thus it will be seen that the manure answers perfectly well so far as the second crop

* In manufacturing a considerable quantity of the mixture to meet a large demand for the present season (1846), I have found much advantage from constructing various utensils of different shapes, so as to perfect the mixture without inconvenience to the attendants, as well as from other improvements in the manipulative process.—AUTHOR.

is concerned; and there is now the prospect of a good clover crop.

The result of the preceding year having fully satisfied me as to the value and economy of vitriolized bones, I did not think it necessary to test their merits against other manures during the last season, particularly as other equally successful experiments had been tried and published.

But wishing to ascertain the most economical proportion of acid to be employed, I prepared two lots for a field of 6 acres. In one the bone-dust was at the rate of 4 bushels to the acre, and the acid one-third; and in the other the acid was half the weight of the bones, but the latter was diminished so as to reduce the cost of both lots to the same sum. The mixture in each instance extended over half an acre more than was intended, and was mixed with equal portions of ashes, viz., about 20 bushels to the acre.

The swedes came up well, and though attacked by the fly, soon got out of its way, and proved a very good crop. The average of the field, however, was very much reduced by the great quantity of hedgerow timber by which it was surrounded, and which spread its blighting influence a considerable distance. However much these trees might add to the beauty of the landscape, they certainly destroyed most effectually the beauty and uniformity of the turnip-crop, and reduced the average of the field several tons per acre. A good portion of the field appeared to average about 22 tons per acre, and the half where the larger quantity of bone-dust with one third its weight of acid was used, proved superior to the other, though whether to be attributed to the difference in the manure or to the fact of that part of the field being somewhat drier, it is difficult to say.

The field was a clay loam on the London clay, and was partially drained.

I also supplied various agriculturists in my neighbourhood with vitriolized bones, prepared in the proportion of 4 bushels (180 lbs.) of bone-dust, and 60 lbs. of concentrated sulphuric acid, which I recommended to be applied to an acre when no other manure was employed. The result in nearly every instance has been decidedly favourable.

Mr. W. Gater of Westend employed it at the rate of 2 bushels of bones to the acre in addition to a fair dressing of farm-yard dung. On a portion of the field the dung was used alone. The former was fit for the hoe several days before the latter, and on weighing portions of each in January last, there was a superiority of 5 tons to the acre in favour of that portion which had received the addition of sulphated bones.

Mr. J. W. Clark of Timsbury used the manure which I supplied him with in the same proportions also in addition to farm-yard

dung, and the swedes proved the best on his farm. The amount of vitriolized bones used per acre varied in different parts of the field, and the goodness of the crop precisely corresponded to the quantity applied.

Mr. J. Blundell of Bursledon also used it at the rate of 4 bushels of bones to the acre, with 6 bushels of ashes in competition with night-soil and ashes. On visiting his farm a few weeks afterwards I noticed at several fields' distance the superiority of one portion of the field, which I found was that on which the vitriolized bones had been used. The dampness of the season, however, proved so favourable to the development of the other manure, that on weighing them in December, the latter was found about half a ton per acre heavier; the expense, however, was nearly double. The weight of the crop was between 17 and 18 tons per acre. I have no doubt that if Mr. B. had applied 20 bushels of ashes to the acre, instead of 6, with the sulphated bones, the result would have been much more favourable. When we bear in mind the large amount of potash contained in the crop, it must be very evident that it is of importance to supply a good quantity of ashes which contain a fair proportion of potash; I would therefore recommend that 20 bushels of ashes per acre, at least, should always be employed.

Mr. Pocock of Hickley used the manure at the rate of 4 bushels per acre, and one-third acid, and was well pleased with the result, though he did not ascertain its amount.

Mr. Withers of Luzborough was another farmer to whom I furnished a quantity, prepared as before mentioned, and he reports very favourably of the results.

Mr. Fielder of Sparsholt was induced by my representation of its favourable effects to try the manure, and he found that on his light land on the chalk it answered admirably. Two bushels of vitriolized bones with ashes successfully rivalled a small portion of ground drilled at the rate of 60 bushels of bones to the acre for the purpose of experiment.

Although the vitriolized bone has proved very successful with white turnips, I believe that its peculiar excellences are most fully proved by swedes. I wished to ascertain this by experiment, and accordingly on the same day and on similar land, a clay loam, 3 acres were drilled with Laing swedes, and 3 acres with Matson's white globes after tares. The swedes proved decidedly superior both in the early and later stages, and though the roots, as might have been anticipated, were but of moderate size, in consequence of the very late time of drilling (early in August), yet on comparing a few rods without manure the difference was very striking. A small portion of the globes, drilled with ashes alone, also exhibited a similar inferiority.

It should be observed, however, that in this experiment the land was probably more suited for swedes than white turnips; but, on the other hand, the lateness of the season was more unfavourable to the swedes, besides which the crop previous to the globes had been manured with stable-dung, whilst the other field had received no dressing since 1843.

Supposing that these results are to be attributed to the greater suitability of the manure for swedes, and not owing to other causes, the result is certainly in keeping with the comparative analysis of the ashes of swedes and white turnips, which tells us that the former contains 408 lbs. of phosphoric acid, and the latter only 73 lbs. in 100,000 lbs. each.

It must be evident from this circumstance that white turnips do not require so large a quantity of bones, whether vitriolized or not, and it also corresponds with the well-known facts that swedes require a larger quantity of dung to supply the necessary phosphoric acid, and also that white turnips on favourable land can be raised with ashes alone far more easily than swedes.

I would therefore recommend in all cases with white turnips, that a less quantity of vitriolized bone be employed, and that guano, or some other manure possessing its properties, should be used in combination with it.

In May last, a portion of land consisting of 1½ acre was drilled with Matson's green top globes, and manured with 1 bushel of sulphated bones, 1 cwt. of African guano, and about 25 bushels of turf-ashes per acre. The crop was a very good one, exceeding 20 tons to the acre.

In several instances within my own knowledge where guano has been used with ashes, the crop has been destroyed by the pungency of the manure, probably owing to the ammonia which it contains. There is no danger of this taking place with vitriolized bones, and I have found, though seeds will not vegetate if entirely surrounded with them, they readily will if the manure is mixed with twice its weight of mould.

The last season has not been a favourable one for displaying the peculiar advantages of vitriolized bones, or rather, it has been from its wetness so favourable for common bones and every other description of manure, that an indifferent field of turnips has been the exception and not the rule. It is in a dry season when the fly is particularly rife and active, when crop after crop is destroyed by this entomological pest, that the advantages of ensuring a vigorous growth to young plants is properly appreciated. Amongst all the specifics or antidotes for the fly, there is none, I believe, equal to the employment of vitriolized bones. Hitherto I have not met with, or heard of, a single instance in which it has failed to force the plants out of the way of the fly. It is in a

dry season too that the advantages of early and vigorous growth are shown, when the plant may languish for weeks for want of rain with ordinary manures, and thus lose time that never afterwards can be compensated for.

In a garden experiment tried on a small scale to show the effect of different preparations in forcing the young plant out of ground, I found the following results:—

1. Vitriolized bone applied in solution above the seed, caused the plant to appear on the fourth day.
2. The same applied below the seed, brought up the plant on the fifth day.
3. Vitriolized bones as compost brought up the plant on the sixth day, both when applied above and below the seed.
4. Sulphuric acid and water below the seed, caused the turnip to make its appearance on the sixth day.
5. Bone-dust below the seed brought up the plant on the seventh day, the same time as it appeared where no manure was employed.

In the above instances, with the exception of the fourth, the expense of the manure was the same in each case.

General Conclusions.

From the facts and reasons which we have detailed and urged in our preceding Essay, as well as from information supplied by previous experimenters, we may deduce the following conclusions:—

1. That superphosphate of lime is the essential manure for turnips, and particularly for swedes. That with it alone a good crop can be raised; but without it the turnip will not thrive, however rich the manure may otherwise be.
2. In preparing the mixture, the bones should be in as fine a state as possible.
3. That sulphuric acid, from its greater strength and cheapness, is preferable to muriatic acid.
4. That water, in the proportion of one-half the weight of the acid, should be first sprinkled over the bones.
5. The proportion of sulphuric most economical to employ, should not be less than one-third, nor more than one-half the weight of the bones, and that probably the medium between these two quantities is most advantageous.
6. That the mixture can be applied either diluted with a considerable quantity of water by the aid of a water-cart, or with ashes by means of an ordinary drill. That though the former may be more speedy in its effects, the latter can be more conveniently applied, and has the advantage of admitting the addition of a large quantity of ashes.

7. That vitriolized bones may be used either alone or with other manures, and that when the latter are at hand, it is more advantageous to use the former in combination with them. For instance, if there are 30 acres to be prepared, and only sufficient dung to dress 15 acres, it is better to give a half-dressing of dung over the whole of the turnip break, and make up the deficiency by means of sulphated bones. Thus the plant will be forced in its early, and supported in its later growth. For the same reason vitriolized bones may be advantageously combined with guano.

8. That vitriolized bones are equally advantageous to the second year's crop, when the turnips are either wholly or partially fed off with sheep.

9. That while the economy of this manure is thus proved by practice, it can be as readily explained by theory, *e. g.*:—The tops of swedes are known to possess double the phosphoric acid contained in the bulbs. Thus, the superphosphate of lime in the manure causes the rapid development of the leaves—one of its peculiar properties. The leaves being thus early and largely developed, are enabled to extract a considerable portion of nourishment from the atmosphere, much more indeed than where the leaves are small and backward. The difference between the amount of food derived from the atmosphere by a forward and flourishing crop, and that obtained by a backward and dwarfish crop, is so much absolute gain to the farmer, or rather to the land. It costs nothing on the one hand, but yields considerably to the land if the crop is fed off on the other. A manure that would thus force on the turnip in the early stages of its growth, was long felt to be a desideratum by agriculturists. This want has now been supplied, and even if this were the only recommendation sulphated bones possessed, its discovery and introduction would still be a boon.

Lastly. The value of vitriolized bone may now be considered to be fully and fairly established. Its claims rest not on the assertions of a few experimenters;—it has been tried during the last season by hundreds with success, and in the next it will be tried by thousands. It affords in fact a triumphant answer to the question. What has science done for agriculture?

Southampton, 27 *Feb.*, 1846.

*** The preparation of bones for turnips, as described by Mr. Pusey (being heated with *ashes*), and other substances, has been long practised with success, and this preparation causes a *softening* of the substance so much that the smaller parts become immediately proper for the food of plants.—J. Kimberley.

X.—*Experiments on the Growth of Potatoes.* By Lord Portman, President.

Dear Pusey,—In compliance with my promise, I now report my progress in experiments on potatoes. I have ripened all the crop raised from diseased tubers. They were put in pots in a cold frame in September, and kept there until December; then were shifted into 8-inch pots, well drained, and kept in a dry heat of 65° and 70°. The whole produce was perfectly sound, and the greater part of the tubers are now growing in the open ground for a crop. One pot was, at the request of Dr. Lindley, moved into damp heat, but kept well drained, and the produce was perfectly sound, but larger and better than those in the dry heat. The potatoes treated with lime, as explained in my letter published in the last Journal, kept well, and were almost all excellent food. A small portion, however, was slightly diseased, and was given to the pigs. The potatoes planted from the crop of 1846 are in the state which I will now describe.

Bryanston Field Potatoes, May, 1846.

Salmon kidney potatoes, planted in November in rows on the flat surface, and 5 or 6 inches deep.

Lot 1. Manured with farm-yard dung, and the potato sets planted *under* it.

Lot 2. Manured with farm-yard dung, and the potato sets planted *over* it.

Lot 3. Planted without any manure, but in all other respects similar to Lots 1 and 2.

All the sets were planted whole, apparently free from disease, and well rolled in lime. The result of Lots 1 and 2 is bad; not more than one in ten of the sets having stood the wet weather of the winter and spring, or the retention of so much moisture by the manure. The sets rotted off at various times, though some, which afterwards rotted, kept sound till the middle of March. The condition of Lot 3 is good; nearly all the sets have grown, and the plants look very healthy and are in vigorous growth. This lot was not manured at the time of planting, but later in the spring, by a top dressing of artificial manure; the soil is dry and light on a chalk subsoil.

Details respecting the Crop in Bryanston Gardens.

Lot 1. Planted in dry ground, on a chalk subsoil 6 inches deep, without manure, but in good condition, in the first week in November. Wimborne kidneys and ash-leaf kidneys; both sorts have come up regularly, and are looking exceedingly well.

Lot 2. Planted during the first week of December. Wimborne kidneys and ash-leaf kidneys; both sorts have come up regularly, and are looking exceedingly well.

Both these lots were cut down by the frost to about $1\frac{1}{2}$ inch below the surface of the ground; in both cases the plants rallied, and grew afresh with vigour. Upon examination it has been found that there were two lots of young tubers; the largest and fewest in number are from the first shoots, the smallest and most numerous are from the new shoots, and very near the surface; a system of roots had proceeded from the shoots at the point where the effects of the frost had ceased, and the tubers there will exceed in quantity the lower tubers.

The potatoes planted in a box in October, in dry heat, produced five successive crops of sprouts from each eye of each potato; the four first crops of shoots taken from tubers planted in the box in the hot-house, and taken off in February, March, and April, grew most vigorously and well, but have since all rotted off with the disease. They were planted in a pit, with brick walls, and since found to be imperfectly drained, but in fresh and healthy soil; and it must have been owing to the warm moisture retained in the pit that the disease affected them. The fifth and last crop of shoots taken from the same tubers in the hot-house, and planted in the open garden, well drained, is looking exceedingly well, and grows fast. The tubers from which all the above were pilfered were taken from the hot-house and planted by the side of their progeny in the garden, which they outstrip in their healthy look and vigour of growth. The potatoes grown in pits for early consumption were sound and good where the drainage was perfect, particularly in the pits whose sides were of turf. In the pit with brick walls and imperfect drainage the haulm was much diseased, and one-fourth of the produce unfit for food. The tubers most diseased were at the lower part of the pit where the soil was most wet, and where little sun could penetrate.

Particulars of Potatoes planted in the field in the early part of April, 1846.

Lot 1. 7 drills of late white potatoes.

With regard to this lot as with all the others (except Lot 5, which was planted with whole sets, and Lot 3, which was planted with the eyes scooped out of the potato), the potato sets were cut into large-sized pieces, planted in well-prepared ground, thrown up into Northumberland ridges, and well manured with farm-yard dung. The sets were put in at the usual depth, and in the ordinary way, over the manure. The plants have come up vigorously and well, and promise a good crop.

Lot 2. 25 drills of Porchester potatoes.

This lot is also regular and good, but inferior in vigour of growth to the first lot.

Lot 3. 25 drills of salmon kidneys, all planted with eyes scooped out for sets, as advised by Professor Playfair. The eyes were scooped out of the potato chiefly at what is called the rose end, and planted on the dung with the eyes upwards. Of 6 bushels of scooped eyes kept in charcoal and lime, 4 bushels were rotten and unfit to plant, probably owing to the place where they were kept having been not dry enough, as it was a shed near the garden well; of the remaïnder, which were planted, one-third failed to grow; two-thirds grew, but look weakly, though good in colour.

One drill of eye-sets (which were scooped out between Christmas and March, and kept very dry in a tin box in a back kitchen, and were healthy and fresh in appearance) looks very well, and the plants are regular and of good colour, but very weakly in growth.

The drills of eyes scooped out immediately before planting are better supplied with plants, and look better than the other drills, but these are weak and vastly inferior to Lots 1, 2, and 6.

Lot 4. 9½ drills of ash-leaf kidney potatoes.

Almost a total failure, though some few of the plants are just appearing above ground. This lot has been carefully examined, and some of the sets are found to be rotten. Others remain just the same as when planted, whilst others have become partially rotten, and have thrown out numbers of small tubers but no shoots. The same thing has occurred in the garden with the last planting of this sort, although the very early planting with the same management has succeeded very well. The cause of this failure is a mystery, for on examination of sound potatoes of this sort, which have remained in store uncut, there is no appearance of disease, or any defect of vegetative power. These are about to be planted, and will be carefully watched as well in the hot-house as in the open air.

Lot 5. 53½ drills of salmon kidneys.

The potato sets were planted whole, and apparently quite sound; they have come up regularly, and are healthy, and of a good colour, but they are a week later in growth (perhaps ten days) than the next lot (6).

Lot 6. 42 drills of salmon kidneys.

The potatoes were cut into two parts, and well dusted with lime. There is a regular plant here, and they are in very vigorous growth.

Lot 7. Planted in the garden during the first week of April, Wimborne kidneys and ash-leaf kidneys.

The Wimborne kidneys are very good, but the ash-leaf kidneys have failed in a manner similar to what is described in Lot 4.

Lot 8. Potatoes from Mexico, cut in two parts; growing vigorously and well.

Lot 9. Potatoes from New Grenada; also growing well, but not so strong as Lot 8.

You shall be informed of the produce of each lot when they have been harvested.

Yours truly,

Bryanston, June 18, 1846. PORTMAN.

XI.—*On the Advantages or Disadvantages of Breaking up Grass Lands.* By JOHN BRAVENDER, F.G.S., Surveyor, Cirencester.

PRIZE ESSAY.

Down Land.

IT might be assumed that, because one person may have obtained, with artificial manures, an excellent crop of wheat from a thin down soil, all such land ought therefore immediately to be broken up and cropped with wheat; but this would not be a fair mode of testing such a step. The wheat crop is only one of a course, and before the farmer can place the least faith in any calculations, the expenses and produce of the entire course must be laid before him. Some of the crops of such course are not *paying* crops, and these should be balanced against those that *pay*. Or if we take the first crop of wheat only, and assume that we shall always obtain the same quantity, we may discover too late that we have difficulty in obtaining the same amount of produce again. Hence we must ascertain what would be the probable produce continuously, under proper cultivation, when the first flush of the soil has vanished. To settle our notions on this subject, if they are wavering, let us make the inquiry. Would it be advisable to break up all the chalk downs in England?—My reply would be, "I think not." Those which are much elevated, or very thin, would not bear corn crops, except at long intervals. Those not too much elevated, would produce sainfoin, and perhaps vetches and turnips, and a corn crop now and then, but would possibly pay better in down, depastured, as now, by sheep folded on the arable land at night. If such lands, after being broken up, could not be maintained as arable, it would be a great mischief to have broken them up at all, because years would be required to restore even such scanty sward as our downs now produce. I should therefore hesitate to recommend the breaking up of land very much elevated, or of very

thin downs. For keeping large flocks of sheep on down land, and folding them on the arable lands, render it unnecessary for the farmer to purchase artificial manures, and enable him to farm in a *four*-field course on a soil naturally fitted for only a five or six field course—adding also one-third to the produce of the wheat crop, and in some cases nearly doubling it. The difference of produce in the wheat crop has been estimated, by those more competent than myself, at 8 or 9 bushels per acre more, on a farm with one-third of its extent in down, and where folding is practised, than on one of similar soil where that practice is not available. This additional produce, which is due to the down, would be gradually lost, and each field on the farm thrown entirely on its own resources; or manures must be purchased to supply the place of that derived from the downs through the means of sheep. Still any portions of downs with a tolerably deep soil, and adjoining the land already in cultivation, may be converted into tillage. In many parts of the chalk downs, however, the farmer has gradually moved up the hill-side until the chalk rock shows itself on the surface, which indicates that he has advanced as far up as is advisable.

Better things may be expected of soils more favourably situated, and of somewhat greater depth, though but a little above them in the scale of natural fertility. Some years ago I had the opportunity of gaining some experimental knowledge respecting this subject, and have since learned from observation that the mode of breaking up land has undergone changes, no doubt for the better. In this report I shall introduce calculations to show what may be expected from breaking up Down and other grass land—not expecting, however, that I can assign prices precisely suitable for every locality, but endeavouring to arrive at a fair general estimate. I may add that all the tabular estimates introduced have been scrutinized by the most eminent practical farmers of the district in which I reside, and have received their approval.

It will be necessary to use some fixed price of the produce, but here we are very much left to conjecture. The averages of grain under the Tithe Commutation Act, for the last ten years, have been—wheat, 7*s.* 0¾*d.*; barley, 4*s.*; oats, 2*s.* 9½*d.*; and the prices of grain for the last quarter, ending Christmas, 1845, are—wheat, 7*s.* 2*d.*; barley, 4*s.* 1½*d.*; oats, 3*s.* 0¾*d.*; rye, 4*s.* 8*d.*; beans, 5*s.* 4*d.*; and peas, 5*s.* 5½*d.* per bushel. It is very doubtful, however, whether those prices will be maintained—indeed we have strong presumptive evidence that they will not, and therefore I have adopted the following rates, as likely to be more permanent:—Wheat, 6*s.* 6*d.*; barley, 3*s.* 9*d.*; oats, 2*s.* 6*d.*; beans, 4*s.* 6*d.* As to the turnips and green crops the prices adopted have been ascertained by experiments, one of which may be men-

tioned. Six acres of swedes were measured off, and the weight per acre ascertained to be not less than 25 tons; 270 sheep were 5 weeks and 2 days in eating them off, and had, besides the swedes, 1 lb. of oil-cake each per day, and as much cut chaff as they desired. Allowing 6*d.* per head per week for the keep of the sheep, this gives 5*s.* per ton for the swedes. Similar experiments were tried in other places, being instituted as a check upon the former one, and by these we ascertained the value to be 5*s.* 4*d.* per ton.

It may be asked, why I have not made use of those results in my calculations of profits? Because out of this amount have to be deducted shepherd's and turnip-cutter's wages, wear and tear of hurdles, expenses of storing, &c. The value of manure, which arises from the turnips being eaten off, is included in the after produce, the crop being estimated higher to meet this consideration. Something might be said on the increase of mutton whilst the sheep are on the turnips, which may appear to be overlooked. If there are those who think something ought to be added for mutton, lamb, and wool, to the profit shown by me, it will increase that amount. By not valuing these things very high, I shall at all events have avoided the evil of putting too high an estimate on the root crops of the farm for home consumption.

ESTIMATE 1.—*Down Land.*

		£. s. d.
Down land, or wolds, with a thin soil on calcareous rubble, limestone rock, or chalk. An acre of such land, in sheep pasture, may be worth 9*s.* or 10*s.*, and will keep only three store sheep to two acres, winter and summer; or produce pasturage which may be equivalent. The sheep at 4*d.* per head per week, will give 26*s.*, say		1 5 0
	£. s. d.	
Deduct rent, tithe-rent charge, and rates	0 13 6	
Labour per acre, repairing mounds, and wages for attending to the sheep	0 3 0	
Profit on capital, 2*l.* 10*s.* per acre, at 15 per cent.	0 7 6	
		1 4 0
Extra profit over 15 per cent. on an acre of down pasture		0 1 0

Down land broken up, and the rent altered to 15*s.* per acre—five-field system:	£. s. d.
1. Expenses of the turnip crop, per acre	3 15 0
[This should not be reckoned merely as the expense of breaking up and sowing the first year. It would not be sufficient for a turnip crop taken afterwards, which would require manure.]	
2. Expenses of the barley crop	2 9 0
3. " " seed crop, mown	0 18 0
4. " " " fed	0 3 6
5. " " wheat crop	2 13 0
5)	9 18 6
	1 19 8

	£. s. d.	£. s. d.
Rent, tithe-rent charge, rates, &c.	0 18 9	
No draining required.		
No charge for interest of money expended in paring and burning, as such land would require the operation, with somewhat less expense, to be repeated after the wheat every course, to obtain ashes to be drilled with the turnips.		
Profit on capital, wear and tear, 15 per cent. on 5*l.* .	0 15 0	
		1 13 9
Average expenditure on an acre		3 13 5

	£. s. d.
Produce of turnip crop, 12 tons at 3*s.*	1 16 0
„ barley crop, 32 bushels at 3*s.* 9*d.*	5 8 9
„ seed crop, 1 ton at 40*s.*, aftermath 7*s.* . . .	2 7 0
„ „ fed	1 10 0
„ wheat crop, 20 bushels at 6*s.* 6*d.* . . .	6 10 0
„ barley straw and wheat straw	1 5 0
5)	18 16 9
Average value of produce, per acre, for the course . . .	3 15 4
Deduct average expenditure for ditto	3 13 5
Surplus profit per acre after breaking up	0 1 11
Ditto whilst in a state of down	0 1 0
Advantage to the tenant by breaking up one acre	0 0 11

The advantage of breaking up an acre to the tenant will only be the investment of additional capital at a good per centage, the balance of 11*d.* per acre not being worthy of consideration. The advantage to the landowner will be 5*s.* per acre increased rent. The advantage to the labourer. the expenditure of at least 1*l.* per acre, which is equivalent to *six* times the amount of labour employed previously to breaking up.

The particular land on which my calculation is founded was broken up at three different times, the last portion in the spring of 1845. If cultivated, as hitherto, on a five or six field course, a profit in all probability will be realized of 2*s.* per acre upon a rent of 15*s.* per acre per annum; and the average expenditure will be 3*l.* 13*s.* 5*d.* per acre. I know that 10*s.* per acre have been added to the valuation of this land for the purposes of the poor-rate, since it was broken up, and its conversion from down to arable was the sole cause of this addition. I also know that the landowner has been offered a rise of 5*s.* per acre per annum for rent, without any outlay whatever. The labourer has obtained an increase of employment which is equivalent at least to 1*l.* per acre. The tenant's profit on pasture is very little increased by its being converted into arable, and he will be subject to an increase in his annual expenditure of 50*s.* per acre, besides the original expense

of breaking up and paring and burning, which would cost from 17*s*. to 1*l*. per acre. It does not appear that any speculation of this kind would answer the tenant's purpose, unless he were satisfied with obtaining 15 per cent. for his additional capital. Were it my own case, with so many contingencies staring me in the face, I should hesitate to break up land exhibiting no better prospects. If leave had been given to the tenant to break up, without any additional rent, the advantage to him would have been 4*s*. 11*d*. per acre. It often happens, in times of difficulty, that a farmer solicits leave to break up, instead of asking for a reduction of rent, and the landowner, seeing a means of preserving his income undiminished, grants the liberty; and in this manner hundreds of acres have been broken up, some with advantage, and some where it may be a matter of doubt, and in other cases with mischief, from persons taking the opportunity of harassing the land previously to leaving it. In cases of the latter kind the landowner has to submit to a reduced rent for the first year or two of the succeeding tenant's entry, a disadvantage that must not be overlooked, and certainly, whatever may be said of restrictions, ought to be guarded against, and the privilege not indiscriminately allowed to all tenants. On this description of land I have shown a very great advantage to the labourer, with a small advantage to both landowner and farmer, and, with care and good management, similar kinds of land may be broken up; and if they are benefited individually, the community must receive benefits in different ways, one or two only of which we need mention. The parish in which the parties live is benefited by the increase of permanent labour, and consequent decrease of poor-rates. The shopkeeper and tradesman are benefited by an increased consumption both in food and clothing, purchased by the labourer, his means being somewhat augmented by constant employment and better wages. The manufacturers are benefited by a brisker demand for wholesale goods by the shopkeepers, who supply the labourer. Thus all must be benefited; and, moreover, when the labourer is fully employed at fair wages, on which with frugality he can live in comparative comfort, he is not found amongst those who increase the burthens of the country in the shape of county and police rates.

The disadvantages on very thin soils are exhaustion, unless care is observed in their cultivation after they are broken up, since in the hands of poor or unscrupulous tenants such lands might be rendered all but useless for a long time.

Near to large towns it would answer to break up hungry sands, thin downs, and light lands, which, at a distance from such towns, I should recommend to be planted in preference. Lands so

situated would be near plenty of manure, that might be purchased for the turnip crops, and if these were eaten off with sheep, and but few corn crops taken, the land would gradually be improved, and become in time as fruitful as the sands of Flanders. The following estimate will be applicable to lands of this description :—

Estimate 2.

	£. s. d.	£. s. d.
No. 1.—Estimate of the expense of cultivating thin sandy soil, after being broken up, and of the profits likely to be derived from it.		
Light sandy or calcareous loam, with rubbly rock under, with a moderate depth of soil, worth 20*s.* per acre to rent. An acre of such land will grow 15 cwt. of hay, or keep little more than two sheep per acre, winter and summer.		
Produce 15 cwt. of hay at 48*s.*		1 16 0
Aftermath		0 7 6
		2 3 6
Deduct rent, tithe rent-charge, rates, &c.	1 5 6	
Labour per acre, repairing fences, and for attending stock, and hay-making when mown	0 7 6	
Profit on capital, at 15 per cent. on 3*l.* 10*s.*	0 10 6	
		2 3 6
		0 0 0

	£. s. d.	£. s. d.
No. 2.—Similar pasture, broken up, and rent altered to 25*s.* per acre—five-field system.		
1. Expense of turnip crop		4 0 0
[This should not be reckoned, merely, as the expense of breaking up, and sowing the first crop. It would not be sufficient for a turnip crop taken afterwards, which would require manure.]		
2. Expenses of the barley crop		2 10 0
3. " " seed crop, mown		0 18 0
4. " " " fed		0 4 0
5. " " wheat crop		2 15 0
	5)	10 7 0
		2 1 4
Rent, tithe rent-charge, rates, &c., after being broken up	1 11 6	
No draining required.		
No deduction for capital expended in paring and burning, as such land as this will require the same operation, at little less expense, at the end of every course, to obtain ashes for turnips.		
Profit on capital, wear and tear, &c., 15 per cent. on 5*l.*	0 15 0	
		2 6 6
Average expenditure on an acre		4 7 10

	£. s. d.
Produce of turnip crop, 15 tons, at 3*s.* 6*d.* per ton	2 12 6
" barley crop, 40 bushels, at 3*s.* 9*d.*	7 10 0
Carried forward	10 2 6

		£.	s.	d.
Brought forward		10	2	6
Produce of seed crop, mown, 1½ ton, and aftermath		3	0	0
„ „ fed		1	15	0
„ wheat crop, 25 bushels, at 6s. 6d.		8	2	6
Wheat straw, barley straw		1	2	0
	5)	24	2	0
Average value of produce per acre		4	16	4
Average expenditure per acre, deduct		4	7	10
Surplus profit per acre, if broken up		0	8	6

Advantage to the tenant by breaking up an acre, 8*s.* 6*d.*; to the landlord, 5*s.* per acre in increased rent; to the labourer, in the increase of manual labour, at least four times the labour required when in pasture; and, to the country in food, more than double the quantity in the shape of beef, mutton, and corn.

A crop of vetches may be grown in addition to the turnips, after the wheat very frequently, and consumed by sheep, and turnips sown afterwards; but their value is included in that of the turnips.

Cold Pastures.

The first step, on lands of a cold nature, is of course to have them thoroughly drained. Their cold state generally arises from a clayey impervious subsoil, and it would be of little use to convert them into arable without draining, which for two or three reasons would be best done before breaking up. The drains are more easily cut, and the carting more easily performed, and with less injury to the land. What is meant by *cold pastures* I consider to be pastures with a very thin coat of surface-soil, mixed and darkened with vegetable matter, on a tenacious clay subsoil. In my observations on such lands I shall consider that draining either has been or is about to be executed; and in my calculations shall charge interest for doing it, and I shall further consider that it has been performed by the landowner, who has a permanent interest in the soil. It sometimes happens that the landowner performs draining to encourage the tenant to farm better, and charges nothing, or even makes the tenant a present of the expense, instead of lowering the rent. Such a step is commendable, because it stimulates to exertion, and has far more practical effect than a return in cash. It cannot lead to carelessness, and shuts out the notion that too often tempts to extravagance, which is engendered by the adage, "Come lightly, go lightly." The tenant having no such permanent interest in the land which he rents, cannot expend his money on the soil of others unless it be returned to him, with interest, by a certain time. He would

require a portion of the capital expended to be returned every year, as well as interest, until he was repaid, and very justly so too. Thus, in consequence of considering the draining to be done at the expense of the proprietor, I shall avoid the trouble of burthening my calculations with additions for return of capital to either the tenant or landowner, simply adding 5 per cent. in the shape of increased rent to be paid by the tenant.

By breaking up those cold pastures that are cold from having only a thin layer of top-soil on poor tenacious clay, we convert them into still colder arable land; and all cold arable lands are very difficult to manage, expensive to cultivate, and uncertain of produce. Farms that are all, or nearly all, arable, composed of such lands, are always more difficult to let when unoccupied, than grass farms of a similar nature, with but little arable. This I am quite positive of from experience, and therefore believe it would be a disadvantage to break up such lands, excepting in small portions. On *such* farms, however, a portion might be of great service in arable, and would not be a speculative undertaking if broken up by a field or two at a time; but where farms are composed of dry sound land, with a field or two of this thin cold pasture, those fields might be broken up without fear of mischief, because the farmer would watch the opportunity, in casual seasons, of weather suitable for their cultivation, and would work them without loss of time. I think it would not be an advantage to break up lands that would remain too stiff for turnips, even after being drained, unless for the purpose of spade culture, because, on farms of any size, such lands could hardly be managed without summer fallow; but there are many lands which we *call* clay-lands that become marly soils on being drained; and if the draining changes their character, though but imperfectly, these will answer to be broken up. Even on heavy clays, where turnips, swedes, and other green crops could not be eaten off on the land, the roots could be consumed in stalls by fat cattle, which would be the means of much enlarging and enriching the dung-heap, especially if oil-cake be used. Many lands of this character have been in arable at some previous day, and some not many years since, that have been left to nature to supply a sward which has not yet been thoroughly effected, neither could it be expected, after being impoverished like the tobacco-lands of Virginia. Such very tenacious soils, of doubtful utility as arable, and in a very unprofitable state as pasture, may be improved by being broken up again for the purpose of being restored to pasture with better prospects for the future, but in doing so, the growing of corn must not be the object. Pare and burn the turf, plough the land, sow green crops, pulverize, and reduce the soddy texture of the soil by eating off with sheep; let this be followed by turnips, manured, to be

eaten off with sheep in the succeeding spring, and then sown with spring corn and grass seeds. This would form a strong contrast to the practice I have witnessed of taking three or four corn-crops in succession, a year of beans, and then wheat, succeeded by three or four other corn-crops again; and at last, when failures have succeeded failures, leaving the land to nature to be renovated. It is against such practices as those, which are injurious to all parties, that landowners must take precaution. If we look into what has taken place under our own observation, and call to mind the mischievous effects that have resulted from the improper use of newly broken up land, we shall cease to wonder at what may be considered absurd clauses in agreements respecting the breaking up of grass land, and the tardiness with which owners of property have given their consent to it; and although we may admit it to be desirable, and can prove its utility, I presume no one will be so short-sighted or careless as to allow it without restriction. There should be some clear understanding as to the future management of the land, for it is to this that the landlord must look. This is what will determine whether it shall be an advantage or a disadvantage—an advantage if well and properly cropped, and well farmed, but a disadvantage if the land be harassed with too many corn-crops, and if little or nothing be consumed upon it; and when exhaustion is complete, the cultivation be abandoned and left to nature, to repair in an age what carelessness had so soon and so recklessly accomplished. The farmer who may be guilty of committing such mischief, although it may be unwittingly, is certainly an injurer of his own interest, a spoiler of his landlord's substance, a scourge to the labourer, and an impoverisher of his country.

The coldest land, however, may be made to answer under cultivation, if suitably managed, as the following instance will show; and though the operations were on a small scale individually, they show what might be done on larger farms:—In North Wilts there is a considerable extent of land called Braydon,* which is singularly notorious for being worthless land. When disforested and disposed of by the Crown it was literally a wilderness of waste. It became the property of various persons, some of whom had estates adjoining, who either planted it or broke up the turf, and

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* I have great pleasure in being enabled, through the kindness of Professor Way of the Royal Agricultural College, to furnish the readers of the Journal with an analysis of this peculiar soil.—J. B.

Royal Agricultural College, Cirencester,
May 22nd, 1846.

My dear Sir,—I have completed the analysis of the soil from Braydon which you kindly sent me. I should remark that, unlike many soils, the one in question is so free from coarse particles that, with the exception of

cropped with corn *as long as they could get a new corn for an old one.* For many years those portions which were not planted appear not to have received any improvement from either the occupiers or proprietors. The cultivation of that which had been broken up was abandoned to nature, and those portions which

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a few fragments of chert, the whole of the soil will pass through a fine sieve. 100 parts of it consist of—

Organic matter	6·74
Clay, sand, &c., insoluble in acids	78·09
Alumina (soluble in acids)	5·75
Silica (ditto)	trace
Peroxide of iron (ditto)	6·24
Lime	0·57
Magnesia	0·43
Potash	1·08
Soda	0·73
Sulphuric acid	mere trace.
Phosphoric acid	ditto.
	99·63

No chlorine or carbonic acid.

In looking over this analysis you will be struck with the smallness in quantity of many of the essentials of vegetable life, and the total absence of others.

The estimation of the sulphuric and phosphoric acids was attempted on unusually large quantities, 500 grains of soil being employed for the former, and 1000 grains for the latter substance. The quantity, however, which was collected was too small for weighing in the most delicate balance. On the other hand, the quantity of organic matter is far greater than in most fertile soils, in all probability due to the district having been the site of an ancient forest.

The *available* silica is also at the minimum. The series of exhausting crops, which this soil in its virgin state was made to produce, has no doubt robbed it of this most indispensable ingredient.

The methods of improving the Braydon land are obvious, but will of course be attended with considerable outlay. In the first place the mechanical texture of the soil must be altered, either by admixture or partial burning. This is absolutely necessary if a fertile soil is aimed at. Stifle-burning, as you observed, would be the best method of procedure. A good liming would be of the utmost value. It would not only add to the soil an ingredient in which it is very deficient, but would have the effect of setting free silica and alkalies, of which there is abundance in the clay, but not in a state for assimilation by plants. Lime would also serve to hasten the decomposition of, and render soluble, the vegetable matters of the soil, which mainly consist of minute roots, &c., having very little tendency to decay, and therefore of little or no value to vegetation.

The additional use of bones and sulphuric acid, and of a moderate dose of common salt, would, I should think, place this land on a footing of fertility equal to any in the neighbourhood. Whether such an expectation would justify the outlay of much capital is a question I shall leave for the decision of agriculturists.

I am, my dear sir,
Most faithfully, yours,
J. Thomas Way.

had been left untouched by the plough still continued to produce a very scanty pasture, considerable portions being covered by furze.

Whilst in this state several years elapsed, and year after year the entire unsevered produce was put up by auction, which very seldom, if ever, realised more than 3*s*. 6*d*. per acre, but more frequently 2*s*. 6*d*. per acre only. One proprietor, however, not content with this state of things, in which there appeared no hopes of amendment, took a bold step, and parcelled out some of his estate into small holdings, or cottage farms, varying them in extent from 5 to 25 acres, to suit the abilities of tenants; and without draining, or in any other way improving the land than by the erection of cottages and outbuildings, let it at rents which vary from 25*s*. to 40*s*. per acre, in addition to the rent for the buildings, the proprietor taking upon himself to pay all rates, tithes, and taxes. It must not be supposed, amongst a number of tenants adopting various modes of cultivation—some, for want of information, abandoning themselves to chance, and others content to watch and imitate the processes of their more favoured neighbours—that all of them were successful in their management; but those who were not so on their first attempts, soon saw in what they erred. In describing the practice of those *squatters of the forest,* I shall select four tenants whose management may be taken as an index of the general practice amongst them. One of those whom I have selected did not succeed at first, from having committed an error which experience has corrected.

A. occupies 5 acres, and has done so for eight years:

The rent is 2*l*. per acre for the land (the house and buildings being charged in addition), but was a little less the two first years. When he took the land it was pasture, almost covered with furze. He grubbed up the furze and burnt it, and, without paring and burning the sward, dug the land from 4 to 9 or 10 inches deep, according as the soil would admit, taking care not to turn up the poisonous yellow clay. It was then planted with potatoes. The crop failed, the produce being only 14 bushels to the acre. After the potatoes were off, the land was manured and dug over again, and sown with wheat, which was hoed in. The wheat was a moderate crop—28 bushels to the acre. The land was very rough during the growth of the wheat, being covered over with sods and coarse grass, which injured it. Paring and burning would have prevented this; and by omitting this essential preliminary he lost his potato crop, and damaged the succeeding wheat crop.

B. occupies 6½ acres, and has had it eight years:

He paid 1*l*. 13*s*. 4*d*. per acre for the first three years, and afterwards 2*l*. per acre, exclusive of the buildings. He cultivated it all with the spade and fork. On first breaking it up he divided it into two parts, on one of which he grubbed up the furze, pared off the sward, and stifle-burnt it, heaping on furze, sward, and soil, as much as he could get to

burn. The other part was done in a similar manner to that of A. Both divisions were dug from 4 to 9 inches deep, the depth varying as the soil varied, and were planted with potatoes. On the part which was stifle-burnt his produce was upwards of 300 bushels of potatoes to the acre, but on the other part the crop was scarcely worth getting in. After the first year this man commenced a regular system of cultivation, having two acres in wheat, two in potatoes, and two acres planted with various crops, small portions being in barley, beans, peas, pulse, turnips, carrots, parsnips, cabbage, mangold wurzel, &c. The land is always manured for wheat, and wheat always follows the potato-crop. He manures with such dung as is produced from his crops, and with such as he can purchase from the neighbouring towns. The wheat is sown broad-cast and hoed in. Beans do not answer very well until the land has received two or three years' cultivation, and then they are almost always sown mixed with peas, producing a crop which is called pulse. His first crop of wheat produced 36 bushels to the acre. The produce varies a little with seasons; but under his cultivation the crop will average 32 bushels. His potato-crop will average 300 bushels, barley 36 bushels, oats 40 to 48 bushels per acre. Turnips 10 to 12 tons per acre; carrots, cabbages, and parsnips, are generally a good crop, cabbages especially. No lime or artificial manure is used.

C. occupies 5 acres, and pays 2*l.* per acre, besides paying for the house:

He broke up half his land and stifle-burnt it the first year. He heaped on as much soil as he could without putting out the fire, with a view of charring it to change the texture. He planted the land with potatoes, and the produce was more than 300 bushels to the acre. The next spring he stifle-burnt the remaining half, and planted with potatoes, and in the autumn of 1842 sowed the other half with wheat, which produced 30 bushels per acre. In 1844 his wheat crop produced 36 bushels to the acre. He always manures for wheat after potatoes, and believes the best course to be, 1st, potatoes; 2nd, wheat; 3rd, barley and green crops. C. recommends that the land should be manured after potatoes for wheat. The stubble should be pared and burnt wherever it could be done. The land should be well dug, keeping the yellow clay underneath; and every effort should be made to keep all kinds of weeds from growing to any size.

D. occupies 23 acres, 14 of which are arable, and 9 pasture. The rent is 2*l.* per acre for the arable, and 25*s.* for the pasture. The buildings are paid for in addition. He has occupied the land for eight years:

On breaking up the land which is now in arable, he pared and stifle-burnt only part of it, and regrets that he had not done it all so. His mode of cultivating the arable is, half in wheat, the other half in potatoes, barley, oats, peas, pulse, parsnips, swedes, turnips, cabbages, broad clover, &c. His turnip and swede crops vary from 12 to 15 tons, and his clover averages 1 ton of hay to the acre. He mows about half of his pasture-land for hay every year, which produces less than a ton to the acre of inferior fodder. He keeps 3 or 4 cows, 2 horses, and a

number of pigs. His corn-crops average the same as those of B.* He sells parsnips, carrots, and potatoes, but not straw or hay, except occasionally; when he is short of manure for his wheat crop, he disposes of a little straw for the purpose of enabling him to purchase manure. He makes it a point to manure for wheat; if he has not sufficient for that purpose he *must* purchase. He also makes it a rule to manure in the spring with the potato crop, and again in the autumn with the wheat; so that the part which happens to be planted with potatoes is manured twice every year. His system of half wheat every year would not answer without doing so. This man, without ever having heard of Whitfield Farm, would appear to be copying from the practice adopted there, but with disadvantages that are not there experienced. The soil he has to work upon is much inferior to that of Whitfield Farm; its aspect is not so favourable, and it is not drained; and besides, he possesses none of that power which an acquaintance with improved implements and machinery bestows, nor the advantages which a familiar acquaintance with science confers.

On very stiff cold clay pastures occupied for dairy purposes, less is returned every year to the soil by the ordinary manure of a dairy farm than has been taken from it, and a corresponding diminution of produce ensues. Not one dairy-farmer in ten has been in the habit of purchasing manure to supply the deficiency occasioned by selling cheese and beef. Many are in the habit of mixing composts from ditch-scourings, road-scrapings, and the mud thrown out of ponds, and of spreading it on the land, and thus have prevented the rapid deterioration which otherwise would have followed. Such slight dressings being generally not sufficient, those lands have been, and are now being, imperceptibly impoverished, and must finally cease to produce cheese in the quantity that will pay the occupier. To counteract this insidious process, the farmer, I apprehend, only requires to be made aware of the fact, and perfectly convinced of its reality. The most evident remedy is to manure with a compost of bones, soil, earth, &c.; but such process will cause an outlay of cash, the return of which might be deemed doubtful. Should this, however, not be done, the country will evidently suffer loss, and a deficiency will slowly and surely arise. It must be evident that dairy-farms which have not had occasional manurings, must be depreciating in fertility, although it may be slowly and insensibly, and those that have not been manured for many years are now bordering on a state of exhaustion for the purposes of dairy husbandry. Such lands require to be renovated; and that old prejudice of "the poorest land makes the best cheese," must be eradicated and banished from the land; yes, and a good deal more must be done, if dairy-

* B.'s Produce.

Wheat	32	bushels per acre.
Barley	36	„
Oats	40 to 48	„
Potatoes	300	„

farming is to be preserved, and be made to keep pace with the improvements that are making rapid strides in the cultivation of arable land. A much less quantity of land must be made to supply the same quantity of dairy produce. The remainder must be converted into tillage, and after being drained where required, will produce an abundance of corn, turnips, swedes, and green crops of all kinds, which are equivalents for beef, bread, and mutton. To appropriate one-fourth of the poorest of our dairy-land upon secondary kinds of soil for the purpose of growing corn and roots, to produce bread, beef, and mutton, and still obtain the same dairy produce from the remaining three-fourths, may appear chimerical, but it is the firm belief of very many practical men who stand high in the agricultural world, that we are destined to effect much more than this. I shall now endeavour to calculate the expenses, produce, and profit on an acre of cold pasture land.

Estimate 3.

Stiff clay pasture, not drained, with a thin covering of mould on the clay subsoil of not more than 4 or 5 inches, and worth 18*s*. per acre to rent. This land would require to be well drained before being broken up. Some such land as this will scarcely produce hay, and is often pastured by young stock, &c. Probably it will be most convenient, if not the most proper, to consider that its produce, although grazed, would be equivalent to about 15 cwt. of inferior hay.

	£. s. d.	£. s. d.
We should then have 15 cwt. of hay, at 40*s*. per ton		1 10 0
Aftermath		0 7 6
		1 17 6
Deduct rent, tithe rent-charge, rates, &c.	1 2 6	
Labour per acre, repairing fences, attending stock	0 5 0	
[Nothing included for mowing and haymaking, as it is doubtful whether it could be mown.]		
Profit on capital, 15 per cent. on 3*l*.	0 9 0	
		1 16 6
Surplus profit, over 15 per cent., on poor cold pasture		0 1 0

No. 3.—Poor cold clay pasture broken up, drained, and rent altered to 22*s*. per acre; 6 or 4 field system.

	£. s. d.
1. Expense of turnip and green crop	5 0 0
[The first crop, with the expense of breaking up, would not amount to this; but afterwards it would reach this amount, or more, on account of manure.]	
2. Expenses of oat crop (too stiff for barley probably)	2 3 0
3. " clover crop	0 12 0
4. " wheat crop	2 18 0
5. " bean crop (manured after)	3 0 0
6. " wheat crop	2 18 0
Carried forward	5) 16 11 0

	£. s. d.	£. s. d.
Brought forward . .		5) 16 11 0
Average expense of labour and cultivation, per acre . .		2 15 2
Rent, tithe rent-charge, rates, &c.	1 7 6	
5 per cent. on 4*l.* per acre for draining, to be charged as additional rent	0 4 0	
[Being a single piece, on a farm with sufficient buildings, no charge made for erecting more.]		
Interest on expenses of breaking up, and for return of capital during the course	0 5 0	
Profit on capital, 15 per cent. on 7*l.*	1 1 0	
		2 17 6
Average expenditure on an acre		5 12 8
Produce of turnip and other green crops, equivalent to 12 tons, at 3*s.* 6*d.*		2 2 0
Produce of oat crop, 40 bushels, at 2*s.* 6*d.*		5 0 0
„ clover crop, 1 ton (aftermath)		2 10 0
„ wheat crop, 26 bushels at 6*s.* 6*d.*		8 9 0
„ bean crop, 32 bushels at 4*s.* 6*d.*		7 4 0
„ wheat crop, 24 bushels at 6*s.* 6*d.*		7 16 0
Straw of oat crop, wheat crop, bean crop, wheat crop . . .		2 6 0
		6) 35 7 0
Average value of produce per acre		5 17 10
Deduct average expenditure per acre		5 12 8
Surplus profit, over 15 per cent., in poor pasture . . .		0 5 2

Advantage to the tenant, in breaking up an acre, of 4*s.* 2*d.*; to the landowner, an increase of 4*s.* per acre in rent, *exclusive* of 4*s.* interest on the expense of draining; to the labourer, in the increase of manual labour, at least eight times the expenditure per acre more than that when in poor pasture, not mown; and to the country, in food, of nearly three times the amount.

It has been customary for persons to argue that the expenses of cultivation are nearly the same on all lands, but this is a mistake. On heavy clay soils it will be difficult to plough with two horses, and a man and his team will not plough so much by nearly a third part in a day; and all the operations of harrowing, dragging, rolling, &c., will be less per day in about the same proportion; and, generally speaking, such lands will require at least one if not two ploughings more for the turnip crop. Even if the fork and spade were used on both kinds of soil, after being once ploughed, the expense would be much greater on the heavy soils than on the light ones. The farmer can at all times get on to light lands, if ever so wet, without injury, but on heavy clay soils he cannot without doing mischief, if the lands be ever so well-drained. This may be said to be an inconvenience only. Let it be so considered, and still there will be a greater expense

in carting off the crops from such land, especially the turnip crop in winter. On the light soils, also, it will not be necessary to haul half the quantity of manure as on the strong land, for the turnip crop. Bones are extensively used on light soils, and a single waggon will take as much to the field as will manure some acres; but on stiff land, not less than twenty journeys of a similar kind will be necessary with farm-yard dung. There are minor matters which are required on stiff soils, such as water-furrowing, &c., which, in spite of draining, will still be requisite; and on slippery roads, cut deep into the mire, there is time lost in going to and from the fields; and if the roads are stoned, there is a trifling expense in maintaining them, whilst on a dry soil nothing is done to the roads, and probably scarcely ever required; and also for such purposes materials have to be carted some distance, but on sound dry light land, generally speaking, there is stone within a few inches of the surface. Roads are not so good nor so easily kept good on clay soils as on light land. The fences are not in so good order, and are more expensive to maintain. Roads, for the purposes of pasture land, would not be required to be used anything like so much as for arable, and might be left unstoned; but for arable they would require to be stoned. In the case of conversion from pasture to arable, the greater use and expense of maintaining roads, amongst other things, must therefore be taken into account, and be set down as some deductions from the advantages produced by breaking up.

Grazing Ground.

It must not be supposed, because, from calculations fairly made, we show a profit on breaking up a piece of land, that on the faith of such, were it even a certainty, we should advocate breaking up all lands without any distinction, and that all pasture land should henceforth disappear. It would not be desirable to carry this into effect if we wished it. Situation, climate, distance from towns, proportion of arable already in cultivation to the pasture, whether to be occupied with or without other lands, and whether of a good or poor thin soil—such and many other considerations must claim a due share of attention, and cannot be passed over as unworthy of notice. Good water-meadows produce three crops per annum: two to be mown and one fed, or two to be fed and one mown, as circumstances may require; and this is done without any manure, except the droppings of sheep and cattle. The hay crop of a water-meadow, in a year, will produce nearly as much manure as the straw would, if such were arable, and of a better quality; and on the average of a four years' course will require as much labour to be expended on it as if it were arable. From this we may easily perceive that water-

meadows are as valuable, if not more so, to the tenant and labourer as the same land would be in arable, and, in the course of years, *more* valuable to the proprietor, because such lands are a never-failing *mine* of manure, without purchase, by which the other lands of the farm will be gradually improved under proper management. Hence to break up water-meadows, or meadows that can be converted into water-meadows, would be to abandon the best and cheapest means of improving other lands—a change which would not benefit any party—farmer, labourer, or landowner. The value of the produce of a good water-meadow will average from 10*l.* to 15*l.* per acre every year, and the same land, during the course, would in arable scarcely average 7*l.* per acre. From this would have to be deducted expenses nearly equal to those of arable, but with this difference: the expenses of water-meadows are all incurred by the employment of manual labour—the labourer performs it all; but in the case of arable, half at least would be performed by horses and machinery.

Again, lands of the best quality should not be broken up, whether in the neighbourhood of towns or occupied elsewhere as grazing-grounds. It would not be profitable to the tenant or landowner; and unless the farm was all pasture, no convenience would be secured by breaking up. If the farm, indeed, did not already possess any arable, convenience would justify the breaking up of a small portion, even upon the best grass farms.

But between the best of our pastures and those at the other extreme, there is a large extent in England not made the most of at present, which there is no question would answer to be broken up; but it would be folly to advocate the breaking up of all such lands, because we depend upon them for cheese, butter, and milk. There can be no doubt but the best dairy land may be broken up, and made to produce large crops, without purchasing manure, simply by raising green crops, and by avoiding to grow two white straw crops in succession; while some dairy lands, rather of a thin description, will require help from other sources, and will be in danger of being impoverished by severe cropping or ignorant management. If a farmer feels any doubt whether such misfortune will happen under his management, he had better not break up the inferior portion here alluded to. The evil would be soon felt by himself, and could not fail eventually to be a disadvantage to the landowner and labourer. The advantage or disadvantage would in this case depend on the character and the means of the tenant.

The pasture-land near large manufacturing towns should not be broken up. The inhabitants obtain their cheese from a distance, but butter chiefly from within a few miles; and, I believe,

the produce of milk and butter has not been more than has been required, and in consequence there is always a demand for those articles for ready money. The tenants of such lands realise a good price and an immediate return, and pay high rents. Farmers living so near to large towns as to admit of their selling milk, make more of their land by so doing than by any other means. I shall now insert an estimate applicable to a small dairy-farm, in which some considerations are made for additional buildings not requisite to be noticed in those which have preceded, on account of our having assumed that the breaking up and cultivation would be undertaken by persons already in possession of every requisite for the purpose.

Estimate 4.

Dairy-farm, of strong and not very deep loam on clay subsoil, not underdrained; worth 28*s*. per acre to rent. This is the kind of land which is frequently found in the occupation of small dairy-farmers, with little or no arable land. Four acres are required to winter and summer a cow; and the produce of cheese is scarcely 3 cwt. This is a farm of nearly 100 acres, 20 of which I propose should be broken up. After the first year of the change the same quantity of cows, or more of other stock, may be kept.

	£.	s.	d.	£.	s.	d.
3 cwt. of cheese, at 56*s*.				8	8	0
30 lbs. of butter, at 9*d*.				1	2	6
30 lbs. of whey-butter, at 7*d*.				0	17	6
Calf				0	15	0
50 lbs. of bacon, at 5*d*.				1	0	10
				4) 12	3	10
				3	0	11
Add pasture for a few sheep on the farm, per acre				0	5	6
Add for beef—every fifth cow being fed and sold: increase of weight per cow 280 lbs., one-twentieth of which, at 5*d*., gives per acre				0	6	0
				3	12	5
Deduct expenses on an acre:—haymaking, carrying and ricking, dairywoman's wages, ditto to milk and assist, salt, anatto, marketing, and wear and tear of utensils	1	1	0			
Rent, tithe rent-charge, and rates	1	15	3			
Ordinary profit on capital, 15 per cent. on 5*l*. per acre	0	15	0			
				3	11	3
Surplus profit on an acre of poor dairy land				£0	1	2

The same poor dairy-land broken up, and drained, and some new buildings erected, at an expense of 120*l*. Four or six field. Rent not increased:—

			£. s. d.
Expense of turnip and other green crops			5 0 0
" barley crop			2 10 0
" clover crop			0 14 0
" wheat crop			2 18 0
" bean crop			3 0 0
" wheat crop			2 18 0
		6)	17 0 0
Average expenditure on an acre			2 16 8
	£. s. d.		
Rent, tithe-rent charge, and rates	1 15 3		
5 per cent. on 4*l.* per acre for draining, to be paid as additional rent	0 4 0		
Interest on expenses for breaking up, and for return of the original expense during the course	0 5 0		
$7\frac{1}{2}$ per cent. on 120*l.*, expended by landlord in additional buildings, barn, sheds, &c., equal to 9*l.* for the 20 acres, or 9*s.* per acre	0 9 0		
Profit on capital, 15 per cent. on 8*l.*	1 4 0		
			3 17 3
			£6 13 11

Twenty acres of this land, converted into arable, may, except on extraordinary occasions, be managed without "summer fallow." I have supposed that the fork will be extensively used, especially in seasons which may be rather critical. On well-drained land, where labourers are numerous, fallows are unnecessary.

		£. s. d.
Produce of turnip and other green crops, equivalent to 15 tons, at 4*s.*		3 0 0
" barley crop, 40 bushes, at 3*s.* 9*d.*		7 10 0
" clover crop, $1\frac{1}{4}$ ton—aftermath		3 2 6
" wheat crop, 30 bushels, at 6*s.* 6*d.*		9 15 0
" beans, 32 bushels, at 4*s.* 6*d.*		7 4 0
" wheat, 28 bushels, at 6*s.* 6*d.*		9 2 0
Barley-straw, wheat-straw, bean-straw, wheat-straw		2 8 0
	6)	42 1 6
Average value of produce per acre		7 0 3
Average expenditure per acre, deduct		6 13 11
Surplus profit per acre if broken up		0 6 4
Surplus profit per acre in poor dairy-land		0 1 2
Advantage to the tenant by breaking up an acre		£0 5 2

Part of this surplus profit might be paid to the landowner as increased rent to the amount of 2*s.* 6*d.* per acre. The advantage to the labourer consists in the outlay of 4*l.* per acre in draining, and also a permanent expenditure of nearly three times the amount over that of the dairy, and the manual labour is doubled.

I have hitherto confined my calculations almost exclusively to the advantage of breaking up single pieces of land unconnected with dairy farming, but this will not form a just criterion for land in the circumstances now to be considered. From calculations on a single piece we may infer the comparative result of

any other quantity, but such comparisons would lead us to very erroneous results. The farmer in exclusively dairy counties is not provided with buildings and implements for arable cultivation, except in few cases—and if at all provided, they are on too small a scale for more than a few acres of arable land—hence we must introduce other and new elements of expenditure.

Where it is intended to break up considerable quantities of land now occupied for dairy purposes, a thing which I deem desirable, where even the buildings are insufficient and where the farmer possesses not a plough or other kind of implement, our calculations must assume a different shape than for single pieces supposed to be broken up on farms where every convenience previously existed.

What I have before shown as advantages of breaking up grass-lands refers to such lands as may be spared to be broken up on a farm without changing the system of farming. A doubt might remain whether it would be of advantage to break up large quantities, especially when the doing so would incur the additional expense of buildings.

I have not hesitated to give as an opinion that little or no advantage would arise from breaking up the best portion of our grass-land, except in small quantities, and that on farms where at present they have no arable land. Neither water-meadows nor those that by any art can be converted into water-meadows, nor pasture surrounding large towns, nor any of our grazing land that will feed an ox on an acre, should be touched. But there are other descriptions of land, down almost to the very poorest, that may be profitably broken up, provided we could ensure that they should not be exhausted, but properly managed and farmed. It is upon lands that are frequently used for depasturing stock and young beasts, and which would scarcely produce a crop of hay if mown, that there will be the greatest advantage in breaking up. Many pastures of this description, that are not on clay soils, but are situated on moist gravel or coarse sand, and produce a very harsh and coarse herbage, will pay when drained to be broken up; as also large tracts of land of an inferior pasture, now occupied for the purposes of the dairy, having been deteriorated probably by a long course of dairying without any or but little return of manure. A long continuance of depasturing for dairy purposes, and of selling of the cheese, butter, &c., without an equivalent return of manure, must finally, if but slowly, reduce the powers of the soil. We meet with a large quantity of land in England which, either from this or some other cause, if not at a stand-still, is yet not improving in the same ratio with most of our arable lands. Heavy lands of this description, generally speaking, are no drained. Little or no attempt has been made to improve

them, and many occupiers do not hesitate to state that to improve the pasture would spoil their cheese. The fact, however, that in some parts of England, and many parts abroad, the richer and better the pasture, the better the cheese, contradicts this notion; and this being the case, I see no reason why it should not be so on every soil. The principal difference is in the management, and not the pasture. It is on dairy-farms of this description that a great advantage will be gained by breaking up a portion of such pasture, which will not only prove an advantage to the farmer, landowner, and labourer, as far as that which is broken up is concerned, but will be the means of so far improving the remainder as to enable the farmer to effect it, and still keep as much dairy stock as ever.

Notwithstanding the advantages shown by our calculations, we must not be so led away by prospects of gain as to induce us to advocate the indiscriminate breaking up of all such pastures, and to feel desirous of doing away with dairy farming altogether. This would be stepping from one extreme to the other, and probably a more dangerous one. I think it will be admitted by all that we are not prepared to give up cheese-making. On rich lands it has not been very much less profitable than the growth of corn to either farmer or landowner when properly attended to. Secondary descriptions of pastures, and such as have been allowed to deteriorate, would be more profitable in arable, and would afford a great deal more employment for the labourer than dairy-farming does on those lands, yet it is a species of husbandry that we cannot dispense with, unless we are to import more cheese than at present. The breaking up, too, of our grass-land beyond a certain proportion would of itself have a tendency to raise the price of the article, the means of the production of which had become much contracted, and at the same time its consumption increased.

Should the time ever arrive when the English farmer shall be enabled to produce cheese from arable land, all our pasture lands, except those of the very best quality, would be broken up. I have every reason to believe that the breaking up of a portion of the pasture land of our dairy districts would be the means of improving the remainder of the grass land, from which an increased produce of cheese would be obtained equivalent to the quantity produced from the whole of the grass land before. If this be proved, I have shown that the proportion which can be thus spared for the plough will be a clear gain to the country.

From examining this subject rather closely, I conclude that *at least one-fourth of the present dairy-pasture may be broken up, and our cheese and butter not be diminished;* and I see a strong probability that our cheese and butter would even increase with

the improvement that would follow the fresh supply of manure, arising from the consumption of the green and other crops of the new arable land. Should such be the result, that proportion which should be broken up would not only be a clear gain to the country, but the increase on the remaining three-fourths would go towards the expense of cultivation, which we have altogether omitted from consideration in our calculations, and our cheese-making population need not be disturbed; but the farmer would be compelled to learn a lesson, which he has hitherto been slow to comprehend and to practise.

The arguments for continuing cheese-making, or rather, for increasing it if we could, are many; but that of affording labour to farmers and labourers fitted for pursuing it from habit and feelings, as well as of ensuring a supply in any circumstances, and of preventing it from becoming enormously dear, appear to be all that will be necessary for us here to notice. It would be clearly impolitic therefore to break up land in a headlong, careless manner, to such extent as suddenly to contract the means of producing cheese for our own market, and at the same time to glut the market with corn and mutton. Such must not be the aim of any one until improved means shall be introduced to enable us, from a reduced quantity of pasture land, to produce as much cheese as is now done, or to enable us to produce as much cheese or a greater abundance from arable land. We probably need not despair of this eventually, but it will be advisable to deliberate before all the second-rate pasture land be broken up.

Having said this much, it will be but fair to state that, in the dairy district of some parts of the country, it is very desirable that some of the land now occupied for dairy purposes should be converted into arable, which might be done with advantage to all parties.

I know many farmers who have not a single acre of arable land, and of course no straw for litter, no turnips or beet to increase their milk, no means of increasing their dung-heap, the liquid manure escaping for want of straw to absorb it, and but little employment for labourers. Lands in this position must, with even tolerably good management, retrograde slowly; and, with bad management, speedily become impoverished. To improve this land, manure or compost must be made from some source or other, and I know of no better means of producing manure for its renovation than by breaking up a portion of the sward and planting corn and green crops in proper course, with which to litter and feed the stock of cattle; taking care to consume about half the turnip crop with sheep on the land, and all the better if with a little oil-cake and corn.

The following estimate refers to a dairy farm with which I am

well acquainted. It is situated on the Oxford clay, and the land is better than any which I have hitherto noticed. The rent is 40*s.* per acre, and the quantity 64 acres. All, or nearly all, of it requires draining; and before any part can be recommended to be broken up, draining must be done. The tenant is a very industrious persevering man, and, as it is now cultivated, barely obtains a livelihood. The rent-charge in lieu of tithes is 4*s.* 3*d.* per acre, and the poor and road rates average 2*s.* 8*d.* in the pound, which on three-fourths the rent will amount to 4*s.* per acre. The rates are rather low in comparison with many parishes, in consequence of a railway which passes through the parish paying about one-third of its rates.

The number of cows kept is twenty, sometimes one more and sometimes one less, varying a little with seasons. Taking out the 4 acres for the keep of a bull, and for the homestead, garden, and buildings, there will be three acres for a cow, and the produce of one cow is $3\frac{1}{4}$ cwt. of cheese, besides butter, &c.

Estimate 5.

		£.	*s.*	*d.*
$3\frac{1}{4}$ cwt. of cheese at 56*s.*		9	2	0
35 lbs. of butter at 9*d.*		1	6	3
35 lbs. of whey at 7*d.*		1	0	6
Calf		0	15	0
50 lbs. bacon per cow, at 5*d.* per lb.		1	1	0
	3)	13	4	9
		4	8	3
Add for beef, every fifth cow being fed and sold. Increase of beef per cow, 370 lbs., one-fifteenth of which at 5*d.* will give the produce per acre		0	10	3
No sheep kept, the pasturage being all required by cattle.				
Average produce per acre in pasture		4	18	6

	£.	*s.*	*d.*
Expenses of management	1	7	6
Rent, tithe rent-charge, and rates	2	8	3
Profit on capital, 15 per cent. on cows and utensils, 7*l.* 10*s.* per acre	1	2	6
Average expenditure per acre in pasture	4	18	3

This would only give 72*l.* per annum for the farmer to maintain his house with; but he performs some of the labour himself, and therefore can just manage to get on, after reserving to himself the pay of a labourer, whose work he performs. There are also some small matters by which he may profit a little, which are altogether omitted in our estimates: such are what may arise from poultry, or the produce of the garden, and the odd 4 acres, part of which may raise potatoes, &c. for the house. All those things added together may make it appear to pay him better than the

calculations show; but, after all, it is clear, as the farmer himself states, that he can *barely get a living.*

Now one-fifth of this farm might be broken up, and after the two first years the farmer will be able to maintain as large a dairy as at present, feed more beasts, and make a larger quantity of manure.

Dairy land of average quality, broken up, drained, and additional buildings erected. 4 or 6 field.

	£.	s.	d.
1. Expenses of turnip crop	5	0	0
[The first crop, with the expense of breaking up, would not amount to this, but afterwards it will require more labour, manure, &c.			
2. Expenses of barley crop	2	10	0
3. " seed crop	0	14	0
4. " wheat crop	2	18	0
5. " bean crop	3	0	0
6. " wheat crop	2	18	0
6)	17	0	0
	2	16	8

	£.	s.	d.	£.	s.	d.
Rent, tithe rent-charge, rates	2	8	3			
5 per cent. on 4*l.* per acre for draining, to be charged as additional rent	0	4	0			
7½ per cent. on 120*l.* expended by landowner in additional buildings, barn, sheds, &c. This may also be charged as additional rent. 9*l.* for 12 acres gives 15*s.* per acre	0	15	0			
Interest on expenses of breaking up, and for return of original expenditure during the course . . .	0	5	0			
Profit on capital invested, 15 per cent. on 12*l.*, including implements, &c. There being no arable, implements would have to be purchased	1	16	0			
				5	8	3
Average expenditure on an acre, in arable				8	4	11

	£.	s.	d.
Produce of turnip and other green crops, equivalent to 25 tons, at 4*s.* 6*d.*	5	12	6
" barley crop, 40 bushels, at 3*s.* 9*d.*	7	10	0
" clover crop, 2 tons—aftermath	4	15	0
" wheat crop, 36 bushels, at 6*s.* 6*d.*	11	14	0
" bean crop, 40 bushels, at 4*s.* 6*d.*	9	0	0
" wheat crop, 32 bushels, at 6*s.* 6*d.*	10	8	0
Barley straw, wheat straw, bean straw, wheat straw	2	14	0
6)	51	13	6
Average value of produce per acre	8	12	3
Average expenditure per acre	8	4	11
Surplus profit on an acre when broken up	0	7	4

The extra profit on an acre when in pasture being nothing, the above 7*s.* 4*d.* would be the advantage to be gained by breaking

up. The fair and equitable distribution of the above advantage might be 4*s.* 4*d.* to the tenant, and to the landowner 3*s.* per acre, besides 19*s.* an acre paid annually in return for his outlay. The advantages to the labourer in employment are, twice the amount of the work of the pasture, and the food derived from the land would be nearly double the money value of the dairy produce per acre.

I now proceed to the second head of inquiry—namely, the best method of turning grass land into arable.

Practice of Breaking up.

The most important preliminary step to be taken previously to breaking up pasture lands is to have them well drained, if the soil be heavy and requires it, and then to pare and burn the surface for the purpose of reducing the grass, weeds, and toughly matted sward to loose, charred ashes, which possess highly fertilizing qualities. The half of the ashes, which are frequently very abundant (in some cases more than 600 bushels per acre), may be carted to other lands about to be sown with turnips, and the other half left for use on the land that produced them. When the land from which the ashes have been derived is very rich and good, the whole are sometimes removed to other parts of the farm; but in this the farmer must always be governed by circumstances. Half the ashes being removed, the remainder is drilled with turnips and green crops on the land broken up, or spread over it before being ploughed. The crop of turnips, which must always succeed, is sometimes eaten off in the autumn, sometimes in the spring, and followed by wheat, barley, or oats. Those crops, according to the soil, are succeeded by vetches, beans, or other green crops, and then regular rotations commence, some of which are indicated in our Estimates, but, of course, subject to variations from soil, situation, and climate. This is a general outline, merely indicative of what may be successfully practised. It has been thought an advantage—an idea not yet entirely banished—to break up land in autumn, to pare and burn, spread all the ashes, and plough and sow wheat; but this has not always been attended with success; and when paring and burning have not been resorted to, the wheat scarcely ever succeeds. The hollowness induced by sods and angular fibrous lumps, with undecomposed grass and roots, render the wheat plant more liable to be killed by frost, and more susceptible of the attacks of such insects and vermin as may have escaped destruction by burning, than when a complete disintegration of the toughly matted sods has been effected, and the fibrous lumps pulverized by the treading of sheep in consuming the previous green crops. The plan of sowing wheat without the intervention of a green crop is uncertain in its results, and will

be discarded by time and experience. The farmer, by merely feeling his way in this matter, has been led to adopt that plan which he has found best, without adhering to any uniform method; and hence may have arisen variations in the modes of breaking up land, which become sanctioned under the name of local peculiarities; and the methods I am just about to describe may possibly possess something savouring of local peculiarity, and as such not applicable to all situations and climates; but I can see nothing to prevent some or other of them from being applicable to lands in all parts of England. The methods for breaking up grass land have not yet settled down into one general principle: I therefore only give the practices that have occurred under my own observation; and for the purpose of confirming those observations I have taxed the kindness of my neighbours, and will concisely describe their most recent practice, with its successes and failures.

The methods adopted by some of them assume the character of experiments, and are so applicable that one might suppose them to have been undertaken expressly to elucidate the present subject. The fact being otherwise will probably render them more valuable, as they come forth divested of everything in the nature of bias; and the persons themselves are ignorant of the purpose for which the information was required; and, besides, I myself watched the proceedings of many with more than common interest.

Case 1.

A very good and well-known farmer broke up a large field of pasture in 1844, and without previously paring and burning, ploughed and sowed with wheat. The land is situated on a level, and not injured by wet. The soil is a moderately light loam of 7 inches in depth on gravel, which rests on a subsoil of clay several feet from the surface. The wheat failed. There were thin patches here and there, with a very fine ear, and on the rest of the land nothing but weeds.

Case 2.

This experiment was made in 1845. The land was covered with a very thick grassy turf, which would have been very difficult to reduce without burning. This piece was intended to be planted with trees. It was pared and burned early in the spring, which produced a large quantity of ashes. They were spread regularly all over the land, and then oats were sown and ploughed in with a thin furrow. The oats were an excellent crop, at least 7 quarters to the acre. This was on poor land, worth about 12*s.* per acre, not more, and not drained. The great abundance of ashes offered a good opportunity for assistance being rendered to other lands, but in this case it was impracticable for want of other lands to take them to.

Case 3.

This farmer, in 1844, broke up a piece of land, a sandy loam of tolerable depth, with a stratum of gravel under, on a subsoil of Oxford clay. This land in pasture produced a very scanty herbage, and was grazed with young stock, and scarcely worth 20*s.* per acre. He pared and burned, and ploughed and sowed turnips, and bush-harrowed them in, the turf being of a looser texture than is often met with, but this operation did little more than cover the seed. He had a very fine crop, which was eaten off with sheep, and in autumn the land was sown with wheat, of

which he had an excellent crop. His next crop will be swedes, barley, seeds, and then wheat again. The method of putting in the turnips is not to be recommended as safe. Certainly not on all soils. About twenty years ago I practised it myself on tender sward with success, but on very tough turf full of the fibrous roots of vegetable substances, &c. &c. it failed.

Case 4.

This farmer in 1843 broke up a piece of pasture-land, the half of which he pared and burned in autumn, and after spreading the ashes, sowed wheat and ploughed it in with a thin furrow, and obtained a very good crop. The other half he ploughed up without paring and burning. The land was harrowed and dragged, and the wheat sown and dragged in. He had but a very bad crop, scarcely worth reaping, with abundance of weeds. The soil of this land averages 8 or 9 inches deep, on gravel, which rests on a subsoil of Oxford clay. The succeeding crops on a four-field course answered very well.

Case 5.

In 1845 this farmer broke up a piece of land, and for the purpose of ascertaining what would "answer best," he pared and burned the sward of the entire piece, and spread the ashes. He then sowed half of it with turnips, and had them breast-ploughed in, covering the seed lightly with little more than the ashes, and had an excellent crop. The other half was ploughed twice or three times, and harrowed and dragged, with the view of doing it well, and reducing it to a fine state previous to sowing turnips. The turnips were sown with the land in nice order, soon after the others just mentioned, and he had nothing. The soil was a light darkish loam, inclining a little to peat, on gravel, with a subsoil of Oxford clay some feet under.

Case 6.

This farmer, an intelligent man, occupying a large farm, in the spring of 1845 broke up 11 acres of down-land, rather thin soil, on calcareous rubble, and determined to cultivate it in two ways for the sake of experiment. He pared and burned the whole of it, and removed about half the ashes to other parts of the farm, which were drilled with turnips. He then spread the remaining ashes, and had about 6 acres of it breast-ploughed, covering the ashes, and shortly afterwards went over it with Croskill's clod-crusher, in an opposite direction to that in which the land had been turned over with the breast-plough, and cut it into squares. It was then harrowed, and the turnips drilled, which are a good crop. After removing part of the ashes and spreading the remainder on the other 5 acres, he sowed turnips, using only half the seed, and then breast-ploughed the ashes and the half quantity of seed in, and immediately after sowed the remaining half of the seed on the top, and bush-harrowed it in. This portion did not answer anything so well as the other, but the turnips were a better crop than some of his neighbours obtained after sainfoin pared and burnt.

Case 7.

In describing how this farmer intends to break up 11 acres of land of two kinds of soil in the same field, I shall only give the methods adopted by him on previous occasions, and which have always succeeded. The field he has now under hand lies at the junction of the forest marble with the great oolite, and is in consequence variable, part on rock and part on clay. The clayey part has been well drained. He intends to plant the part on the rock with turnips, and the other part with swedes. His process will be as follows: To pare and burn the turf in the spring, as early as the weather will permit, and haul away half the ashes to be drilled with turnips on other land. To rafter-plough, and leave it for a month or so to the influence of the sun and weather; then drag it, to pulverize it as much as possible, and after having harrowed it, to plough it clean, with a slight furrow, and then drill white mustard with a portion of the ashes, on the lightest part, reserving the other portion for swedes. The mustard will come up soon, and be ready for sheep in about a month after being sown. The mustard is to be eaten off with

sheep in folds, and the land immediately ploughed, dragged, harrowed, and then turnips are to be drilled with the remaining ashes. Of course, between the time of sowing the mustard on the lightest part, and its being eaten off with the sheep, the stronger portion will be cultivated and drilled with swedes. Both the turnips and swedes will be eaten off with sheep in folds; the turnips first, and the swedes afterwards, and sown with wheat, unless circumstances render it desirable to reserve them until nearer spring, in which case the land will be sown with barley; but the former plan of sowing wheat is most usually practised. This method has been adopted by him on other lands before, and he has always had abundance of green crops and turnips, and plenty of good corn afterwards.

Case 8.

Another farmer very close to me, and whose operations I have watched with considerable interest, in the spring of 1844 broke up about 7 acres of land, situated on the forest-marble clay, with a covering of darkened soil 8 or 9 inches deep. After paring and burning, part of the ashes was removed to other parts of the farm, and drilled with turnips. This piece produced a large quantity of ashes, and the portion which was left behind formed a thickish covering for the land. It was ristbalk-ploughed, with a thin furrow, and left for a month exposed to the influence of the atmosphere. It was then dragged across and harrowed to pieces, and in June ploughed with a clean furrow and sown with turnips, and afterwards rolled down. The turnips were an excellent crop, certainly more than 25 tons to the acre, which were nearly all eaten off on the land in September and November, a few being taken home and consumed in the stalls. The land was afterwards sown with wheat, and there is a very excellent prospect of a crop. The plant looks exceedingly healthy.

Case 9.

Although the last party alluded to succeeded to his "heart's content," the following is a more signal instance of that success which, with favourable seasons and opportunity, reward the activity and perseverance of intelligent men. This farmer has in the years 1841 and 1845 broken up more than 40 acres of very poor pasture-land, situated on the forest-marble clay, some of very tenacious character, with a depth of 6 or 7 inches of soil on the top. These lands were first well drained at the expense of the landowner. The cost was nearly 4*l.* 4*s.* an acre, exclusive of hauling, which was performed by the tenant, who also superintended the workmen. He pared and burned and cropped the greater portion of it, after the manner of the last party referred to, and succeeded fully as well, if not better. A portion of this land which here more particularly claims our notice, was managed otherwise, with complete success. Instead of letting it remain idle for a month, exposed to the atmosphere, he determined on sowing it, as soon as the sods were burnt, with white mustard. This was done immediately, drilling it thick, 16 lbs. to the acre, with a portion of the ashes, leaving a portion for the intended succeeding crop, half of the whole quantity, which was large, having been hauled away to other lands. The mustard succeeded wonderfully. In less than five weeks it was ready for the sheep to eat off. The land was immediately ploughed up, dragged, and turnips drilled with ashes. The turnips were an excellent crop; they were, in their turn, eaten off with sheep in September and November; the land was then ploughed and sown with wheat, which, as may be supposed, is very promising.

I could select a multitude of instances of failure and of success, but it would be useless to multiply cases. It will be evident that the safest plan is always to let the first crop be a green crop, eaten off with sheep, by which the soil becomes pulverized and consolidated, otherwise it will scarcely bear a profitable crop of corn. When a corn crop is taken first, there is great danger of the crop failing in consequence of hollowness produced

by the tough nature of the *under*-turf, which atmospheric influences alone during the first year's crop fail to disintegrate. If the plants be not blown out of the ground altogether in the spring by winds, and a sufficient number escape the ravages of insects and the wireworm, yet without consolidation by the treading of the sheep while eating off the previous green crop, a large quantity of straw is produced, which from its weight in a green state, and from the spongy texture of the soil, is very often laid, and the yield of corn very far short of the expectation of the farmer. But this state of things scarcely ever follows the eating off of the green crop, therefore we may at once decide that it would always be the best plan, first, to take green crops, which of course will vary with the nature of the soil; turnips on light lands, swedes on a stronger soil, and rape on peaty soils. Should circumstances render it desirable to break up lands in autumn, August would be a suitable time before harvest commenced. White mustard should be drilled rather thick, which in about a month will be ready for the sheep. It should be eaten off on the land, which will be effected in good time for wheat. The treading of the sheep will break down the sods, and the land will plough up in a much mellower yet firmer state than it would have done without the green crop. Should any one venture to break up land, and to sow wheat without the intervention of a green crop, probably folding the sheep on the wheat, in the following spring, will be a means of saving the crop. This I have repeatedly seen done, and in some instances with much advantage.

It has been a custom for many years, on breaking up sward land, to commence the operation with paring and burning. This practice scarcely requires further experiment to establish it as an essential preliminary. The burning kills insects that would otherwise devour the turnips and the succeeding wheat, it destroys the roots and seeds of weeds, and reduces to ashes the turf that would cover the land in the shape of loose sods, and render it too hollow for wheat after the green crop. Burning produces too a highly fertilizing manure, composed of a mixture of ashes, burnt soil, and charred vegetable matter; impregnated with alkaline salts, which are known to be powerful promoters of vegetation. Generally speaking, land which is selected to be broken up is covered with a large quantity of coarse grass, furze, briars, blackthorns, straggling heath plants, rest-harrow, sedge, rushes, and many other coarse and woody-stemmed plants, which could not be made to decompose with sufficient rapidity without burning. By burning, and especially stifle-burning, the roots, fibres, and stems of plants become charred and are deprived of that tenacity which binds the sods together in matted masses.

The modes proposed for tilling each kind of land after being

converted into arable will in a great measure be indicated by the succession of crops named in our estimates. But the nature of the soil of our island is almost as variable as the rocks on which it rests, and therefore the rotations which I have named can only be applicable to a limited extent. They cannot be strictly applicable to all soils, nor to the same soil in different circumstances. There are exceptions to all rotations arising from situation, climate, soil, population; and, therefore, I dare not presume to offer them as applicable under all conditions. They are only indices of that system which may be successfully applied on soils having characteristics in common with those which we have mentioned. Even on the soils possessing those general characteristics, the crops may be very much varied from those which we have named. Thus it may occasionally be best to sow oats instead of barley, and beans and other green crops on a portion of the land which I have assigned for seeds, and many other changes may arise from circumstances, which will cause the farmer, indeed compel him, to deviate from those systems; but if he adhere to the one grand point, of following the white crops with green crops, whatever system he may adopt will have nearly the same result as those proposed.

On thin light calcareous or gravelly soils, sainfoin will answer better than seeds, and therefore should be substituted. The strong fibrous roots of sainfoin operate on the thin loose soils of calcareous rocks, like the *arundinaceæ* on the sands on the sea-coast, in imparting cohesion to the soil. Sainfoin also produces by the time it is worn out a tough sward, full of vegetable matters, which by paring and burning furnish a large quantity of ashes, exceedingly useful to the succeeding turnip crop. It will therefore be desirable to sow sainfoin on all such lands, with the view of modifying the physical character of the soil, as well as to obtain manure for turnips, and a large quantity of feed from poor thin soils, sometimes exhibiting scarcely anything on the surface but the comminuted portions of rock, on which, however, sainfoin flourishes and remains in vigour for years. Downs are principally confined to the chalk, and there sainfoin will often take the place of seeds after barley, lasting for five or six years. It arrives at perfection the second year, and begins to decline about the fifth, after which the breastplough is diligently used, and turnips succeed. In our estimates we have considered the green crop to be comprised in the term *turnip crop,* which is made up of tares or vetches on all the better kinds of light loams after wheat, which are the same season succeeded by turnips. On stiffer kinds of soils the green or fallow crops, which are to be partly consumed on the land, are composed of swedes, turnips, cabbages, mangold-wurzel, vetches, and white mustard; and on

good loams of a sandy character, in addition to those mentioned, carrots, peas, rye, and buckwheat; and, on peaty soils, rape. It will answer the farmer's purpose to vary these green crops as much as possible, and not repeat the same kind on land that during the previous fallow had been planted with it.

In breaking up old sward land there are almost always more ashes than are required for the turnip crop. The surplus is taken away to other parts of the farm and drilled with turnips and bones, leaving the farm-yard dung in greater abundance for the swedes, Newly broken up land may thus be rendered a source of improvement on the remainder of the farm. The ashes thus appropriated will cause a better crop of turnips to be grown on the other land for that season, which, when eaten off, will retain the sheep longer on the land, and create more manure, and ensure a better and more regular consolidation. This consolidation, as well as the increased turnip crop, is of great consequence on light loams, the effects being apparent through the entire course. More corn is the result, and of course more farm-yard manure. And when such land comes in turn for turnips again, it receives a better and heavier dose of this, the best and most useful manure.

With the modern good management, and plenty of green crops, to break up a piece of sward land is of considerable benefit to the whole of the farm. It enables the tenant to commence the improvement of his land in the most simple and economical manner.

It will not be desirable to attempt to make thin soils deeper by ploughing up the hungry rubble or poisonous clay from beneath all at once. If done at all, it should be done gradually, and each successive attempt be made before winter, to give the land a chance of becoming tempered by the frost and reduced by atmospheric influences. In spite of what is said in favour of deep ploughing in the north, it will not answer on all soils, and even on those that would in the end be improved by being deepened, it would not be advisable to do it all in one season.

On the choice of Land to be broken up.

Our prescribed limits will not admit of this portion of the subject being treated at length, I shall therefore only insert a few summary observations. Probably they may not be the less useful for assuming this condensed appearance.

Lands that may be broken up.

Chalk downs of good depth of soil.

Chalk downs of the depth of 5 or 6 inches on farms where there is a great portion of down land, but care must be taken not to harass the land with too many corn crops.

Lands of light, dry, sandy, gravelly, rubbly nature, on a rocky or porous subsoil, with a southern aspect and gentle inclination.

Large tracts of rough pasture, now of no great value, which are used for rearing young stock, especially that with a clay subsoil or gravel on a subsoil of clay, which is kept cold and moist through want of draining.

All cold pastures, with a subsoil which changes to a marly substance on being dried, and which becomes shivery and splits upon being wetted again, and which falls to pieces on being exposed to the atmosphere.

Strong shallow loams on limestone rubble.

Dry loams intermixed with clay.

Deep moist running sands that are favourably situated for turnip culture.

Lands of moderately light sandy nature, but of considerable depth, on porous rock, or on gravel of a considerable depth, on a tenacious subsoil.

Peaty soils with subsoils of calcareous clay. The clay may be serviceable in consolidating and imparting cohesive power to the peat. Gravel will sometimes have the same effect. Peaty soils should if possible be converted into water-meadows.

Very stiff soil, with little surface soil, for the purposes of field gardens to be cultivated by the spade or in cottage farms of a few acres.

Heavy cold clay lands which are rendered porous and friable by draining, but near to and adjoining large towns. This description of land should be reserved to supply milk, butter, &c. &c. to the inhabitants, which would pay the farmer, and of course the landowner, as well and perhaps better than it would if it were broken up. Such lands are favourably situated for improvements from manure, compost, &c.

Heavy lands that are stiff and tenacious throughout their substance because of the moisture they retain, but which change their texture by draining.

Cold sandy loams, forming pastures of a medium character, frequently occupied for dairy purposes, which cannot always be denominated cold clays, but rather cold sandy loams on a tenacious subsoil, from the abundance of moisture they contain, and which are comparatively barren from want of draining and better cultivation.

Pastures intrinsically of a secondary character, and a portion of those which have been reduced to that state by long-continued careless dairy management. Breaking up will recruit the former, and enable the latter to recover their lost fertility.

Lands of this description might be made a great deal more of than they are at present. They might be so far improved as to supply the deficiency of dairy produce which would arise from breaking up one-fourth of the whole quantity of such land. All the farmers thus situated would afterwards find it unnecessary to purchase wheat. The quantity to be broken up must always be governed by circumstances. There are situations where it would not be desirable to break up more than 10 per cent., just barely enough to produce straw, &c. for litter, and on others half to three-fourths the farm; but this cannot be recommended to be done at once. Probably the situations are not very numerous where it would answer to do so, and any prudent person of course would *feel his way* by beginning on a small scale at first. On dairy farms without arable, 20 to 30 per cent. may be appropriated for arable culture, but this should not be all undertaken at once. If done by degrees the effect may be watched, and if unpropitious the coming storm may be averted by desisting in time. Except in particular circumstances I am not prepared to advise a greater extent to be broken up.

Lands that should not be broken up, or concerning which the farmer should deliberate, and be fully satisfied of the nature of the undertaking before he begins.

Very stiff clay soil, with little or no surface-soil, and not drained, should be trenched and planted.
Elevated poor sandy or rocky clayey soils should be planted in preference.
Lands that are poor from the thinness of the soil.
Very light shallow loam on rock, limestone, &c.
Very thin chalk soil which exhibits the naked rock, or coarse debris of the chalk, on or very near the surface.
Deep moist running sands that cannot be conveniently drained, should be trenched and planted.
Poor clay soils, on a cold-bottomed retentive subsoil, and northern aspect.
Very poor ferruginous sands which are covered with heath, unless in peculiar circumstances.
Rich feeding pastures.
Water-meadows, and those that can by any likely means be converted into water-meadows.
Fine rich alluvial pastures and meadows.
Accommodation lands near towns.
Dairy farms *near towns:* lands which are occupied for the purpose of supplying the inhabitants with milk.
Rich pasture lands.
Lands which are liable to floods. If converted into arable, the best portion of the soil would be in danger of being swilled away.
Lands adjoining and near to the homestead. This rule is frequently violated on the chalk.
Salt marshes; and doubts may arise about other marshes: locality, and facility for draining them, will best determine their eligibility.
Very stiff clay that would require to be summer fallowed for wheat. Small portions for spade culture may be excepted. Such lands may be much improved in pasture by draining, and occasional swillings with liquid manure; and frequent dressings with soil, rubbish, road-scrapings, &c., made into compost, and spread over them when practicable.

The elevation of lands above the level of the sea is a matter that is worthy of consideration. Lands much elevated, apparently possessing the qualities which would in other situations determine their eligibility, would not answer, because of the crops not ripening in a kind and natural manner. I should hesitate to convert any land into arable raised more than 1000 feet above the sea, unless the aspect was favourable, and the locality not farther north than the 53rd degree of north latitude. When situated at or beneath this level, aspect will assist us a little in our choice. Thus, if we have two fields at an elevation of 1000 feet, one with a southern aspect, sloping away at a gentle angle, and the other with a northern aspect, also sloping away with a moderate angle, and we wish to convert one of them into arable, our choice would naturally fall on the field with a southern aspect, because, at this critical point, aspect alone might be sufficient to turn the balance. Corn grown above the height of 1000 feet is uncertain of producing good grain: hence, to break up lands much elevated, unless something local sanctioned the proceeding, would be to exchange a certainty for an uncertainty—a step which generally indicates a deficiency of judgment, and which is of too speculative a character for the cautious agriculturist to indulge in.

Advantages to the Farmer in Profit, and the Landowner in Rent.

Besides the profits that will accrue to the tenant and landowner by breaking up land to a moderate extent, which are shown by our estimates, there are others which cannot be subjected to calculation, and which will arise from the saving of rates, in consequence of the labourer having full employment, probably to the amount of one-fourth of the Union expenditure. Poor, police, and county rates are all diminished when the labourer is in a comparatively comfortable condition. It is constant employment at fair wages that will tend to secure this more than anything else. A small patch of land, a pig in the sty, and constant employment at "fair wages for a fair day's work," are all that is requisite to secure to the labourer this comparatively comfortable condition; and these things are surely not more than justly his due. The consequence of our placing him in this condition would be a certain reduction of rates, and whatever that might be it would be all gain to the occupier. But the profit to the tenant would not stop here. If the farmer obtains no profit whatever beyond that which we have assigned, he would secure to himself a safe investment for additional capital at good interest. He would obtain 15 per cent. upon the difference between the expenditure and capital employed in cultivating the pasture and that which he would be required to employ in cultivating the same land in arable; and also, if there be profit in cultivating the soil, and if it be true that the better the cultivation the greater the profit, within certain limits, the farmer would be adding to his profits not only in the saving of rates, and good interest on additional capital, but by employing men to ensure a better and more perfect cultivation of the soil, he would be actually profiting by their labour, which in other circumstances would have been lost to himself, while the benefit of increased produce would have been lost to the country.

The following, then, are the *surplus* profits to landowners and tenants to be derived from breaking up certain lands, over and above the *ordinary* profit on the capital proposed to be thus invested, as collected from my estimates:—

	Tenant.		Landowner.		Total.		
	s.	*d.*	*s.*	*d.*	£.	*s.*	*d.*
Down land	1	0	5	0	0	6	0
Thin sandy loam . . .	8	6	5	0	0	13	6
Cold pasture . . .	4	2	4	0	0	8	2
Dairy farm of 100 acres . .	5	2	..		0	5	2
Dairy and grazing land . .	4	4	3	0	0	7	4
					5) 2	0	2
					£0	8	0½

If we knew exactly the extent of land in England and Wales answering to each of the above descriptions, we might arrive at a

tolerably correct conclusion respecting the total gain to the landowners and occupiers; but for want of correct statistical information we cannot make very accurate calculations—we cannot generalise with safety; and were we to speculate on averages without qualification, our conclusions might assume the character of certainty instead of being approximations only. With due qualification, however, we may venture a few calculations on the imperfect data which we possess. Supposing, then, 8*s.* per acre to be the fair average profit, and that one-fourth of our pasture may be broken up without inconvenience—without disarranging the present occupancy, or straightening the means of producing the present or even a larger supply of butter, cheese, and beef—we shall have the aggregate profits of landowner and tenant exhibited in the succeeding calculation, which I shall preface with such statistical information as is within my reach. For want of better information, this calculation is founded on a return which was made to Parliament in 1804, of all lands in England and Wales, and the manner in which they were cultivated; and on a statement in Chambers's 'Information for the People,' quoted from Mr. M'Culloch in 1842. The pasture is stated at 17,000,000 acres by both authorities, but a difference arises in other respects. From these authorities the following particulars are derived:—

From the Return to Parliament in 1804.

		Acres.	Acres.
Extent of land in	wheat	3,080,000	
"	barley	850,000	
"	oats and beans . . .	2,800,000	
"	clover and rye grass . .	1,120,000	
"	turnips, carrots, cabbages, &c.	1,120,000	
"	fallow	2,100,000	
			11,070,000
"	hop-grounds . . .	35,000	
"	nursery-grounds . . .	8,500	
"	fruit and kitchen gardens .	45,000	
"	pleasure-grounds . . .	16,000	
			104,500
"	depastured by cattle . . .		17,000,000
"	hedgerows, copse, and woods .	1,600,000	
"	ways and water, &c. . .	1,282,100	
"	commons and wastes, &c. .	6,277,800	
			9,159,900
Total quantity of England and Wales . . .			37,334,400

From M'Culloch.

		Acres.
Extent of land in wheat		3,800,000
"	barley and rye	900,000
"	oats and beans	3,000,000
"	clover	1,300,000
"	roots (turnips, potatoes, &c.) . .	1,200,000
"	fallow	1,650,000
Extent of pasture land		17,000,000
"	land in hops, gardens, &c.	150,000

From Dietrichsen and Hannay's Royal Almanac for 1846.

	Arable and Garden. Acres.	Meadow Pasture and Garden. Acres.	Wastes capable of Improvement. Acres.	Incapable of Improvement. Acres.
England . .	10,252,800	15,379,200	3,454,000	3,256,400
Wales . . .	890,570	2,226,430	530,000	1,105,000
Scotland . .	2,493,950	2,771,650	5,950,000	8,523,930
British Isles .	109,630	274,060	166,000	569,469
	13,746,950	20,650,740	10,500,000	13,454,799

From the second statement it appears that the pasture land was considered to be the same in quantity as in 1804, but there had been an addition to the arable of 780,000 acres, and a deduction from the lands fallowed of 450,000 acres.

Many of those items have varied very much since 1804, much more than is indicated by Mr. M'Culloch in 1842. The hop-grounds have nearly doubled, and roads, railways, and canals have increased their extent by several thousands of acres; but, on the other hand, the quantity of common and waste has diminished to a greater extent. There has also been a considerable quantity broken up, and some returned to permanent grass again. The high prices which prevailed during the period from 1815 to 1820 induced farmers and landowners to break up a large quantity of pasture, but to what extent I am unable to ascertain, and am also left to conjecture as regards the quantity returned to grass again. For the last twenty-five years I have carefully observed what has been taking place in many parts of England, and am certain that the quantity of arable has increased, or, which is the same thing, the pasture has decreased probably by more than 1,000,000 acres, without reckoning that which may have been enclosed from commons and wastes under Acts of Parliament, and broken up. I am inclined to think that there are now left somewhere about 16,000,000 in pasture. Assuming this to be correct, and that one-fourth only may be safely spared, we shall have 4,000,000 of acres at 8*s*. per acre, which will amount to 1,600,000*l*. This, then, would be the annual gain to landowners and farmers by breaking up generally, in England and Wales, that small portion only which I have presumed to recommend to be broken up—not exceeding that limit until the result of advancing thus far shall become known. This sum might be divided between the landowner and occupier as they best could arrange the matter; but, should it be necessary, I have no doubt of the landowners being willing to give up their claim. In such case, the most active, intelligent, and persevering tenants would obtain the greatest share; and who is there that would not rejoice on finding that zeal and activity, talent and industry, met with their just reward? To show, from plain and dispassionate reasoning, that more than 1,500,000*l*. of increased income is within the com-

mand of the landowners and farmers of England and Wales, provided they will adopt the proper means of obtaining it, I have considered my legitimate business; but whilst pointing this out to them, I feel the necessity of advising that it may be set about with judgment, caution, and deliberation. Men who duly deliberate first, and proceed with caution afterwards, seldom fail in their undertakings; and to such only should I trust the breaking up of lands and their future management, especially those lands the soil of which is of a doubtful character.

The Advantages to the Labourer in Employment and to the Country in Food.

It has been usual to assume that one man will be required for every 25 acres on an arable farm; but this is seldom or never realized. Probably not more than one man to 50 acres is really employed on light soils, and not a much greater proportion on all moderately heavy soils: but to follow out the system I propose by abandoning summer fallow, and occasionally, if not every season, using the fork and practising hand-picking, will require a larger proportion of labourers than has hitherto been employed on the same extent of land. On an average one man to every 20 acres will not be found sufficient on lands of similar character to those referred to in the Estimates 4 and 5. Shed-feeding sheep, stall-feeding cattle, and soiling, are practices which will gradually force themselves on the farmer's notice. It is also more profitable to keep working horses and oxen in yards on clover, vetches, and sainfoin; and were the plan to be generally adopted, all the land on which they have hitherto been grazing would be better broken up. Those lands are, generally speaking, not of the best quality, and for that, amongst other reasons, would answer better under the plough than in pasture. It may be so said of dairy cows, but that cannot be realized until we shall have advanced some steps further in agricultural science, and are enabled to make good butter and cheese from seed pasture, vetches, sainfoin, clover, and roots. If we could accomplish this, cows might be soiled in yards, and supplied with food from the arable land, which would be the means of creating a vast amount of additional employment for the labourer, independent of the breaking up of their former pastures. Nearly all the lands occupied by dairy farming might then be broken up, without fear of a scarcity of cheese, butter, or milk. Should the time ever arrive when even half of the land thus occupied can be spared to be converted into arable, we shall increase our produce of food for man and beast to an amazing extent, and there would not be found a man, who is willing and able to work, out of employment: and what is more, the labourer would obtain fair wages for his services, in consequence of the removal from the

market of his brethren, who have hitherto been driven to the necessity of underbidding him, and who have been involuntarily running a race with him to obtain employment.

Four million acres of our grass land, however, may even now be broken up without inconvenience, or any great change in our systems of management: and could these four millions be set free for arable culture, with a certainty of being well farmed, the advantage, as I have already shown, would be great to the farmer and landowner, but the advantages to them would become comparatively insignificant when compared with those conceded to the labourer and to the country. Of the four millions a fourth would be planted with wheat every year: but, to be on the right side, let us assume that one-half would be cropped on a four-field and the other half on a five-field system. The average produce of the former, according to the estimates, would be 32 bushels, and of the latter 24, making a general average of 28 bushels per acre, which is certainly rather under the mark than over, as I intend it should be. This would give 900,000 additional acres of wheat, producing annually 3,150,000 quarters, which would be more than sufficient to supply the deficiency of our home growth of this grain, without reckoning the beef, mutton, and green and other crops, which would greatly exceed the present produce of such lands in pasture.

Calculation of the Gain of Food to the Country.

	£.	s.	d.	£.	s.	d.
1. Average of the yearly produce of an acre of down after being broken up				3	15	4
2. Ditto ditto on light sandy soil				4	16	4
3. Ditto ditto on stiff clay land				5	17	10
4. Ditto ditto on strong dairy loam				7	0	3
5. Ditto ditto grazing dairy farm				8	12	3
5)				30	2	0
General average				6	0	5
1. Average value of the yearly produce of an acre of down before being broken up	1	5	0			
2. Ditto ditto on light sandy soil	2	3	6			
3. Ditto ditto on stiff clay land	1	17	6			
4. Ditto ditto on strong dairy loam	3	12	3			
5. Ditto ditto on grazing dairy farm	4	18	6			
5)	13	16	9			
				2	15	4
Average increased value of produce per acre by being broken up				3	5	1

This 3*l.* 5*s.* 1*d.* is the value of 10 $\frac{1}{10}$ bushels of wheat: that is—if my estimate be a just one, and I see no reason to the contrary—

it is clear, that by breaking up pasture land we shall gain an increase of food for the people to the amount of 10 bushels for every acre that should be broken up. This increased produce of 10 bushels on every acre would give 30 bushels for every 3 acres, and thus the increased produce of every 3 acres would provide bread for a family of five persons for the twelve months. Hence the breaking up of four millions of acres of pasture land that may be spared for the purpose, to be farmed on a self-supporting system, would enable us to provide bread for at least a million families.

We now come to the amount of manual labour on the land in the state of pasture and arable, and in showing the difference I shall still use the figures of the Estimates already given. The manual labour on the five kinds of land in the original state of pasture, and where it is converted into arable, and cultivated and cropped after a suitable manner, is nearly as follows :—

	Expenditure on Labour per acre in Pasture.	Expenditure on Labour in Arable per acre.		Increase of Labour.
	£. s. d.	£. s. d.		
1. Down land . . .	0 3 0	0 19 3	or	6-fold.
2. Light sandy pasture .	0 5 0	1 0 0	or	4-fold.
3. Stiff clay . . .	0 4 0	1 15 6	or	8¾-fold.
4. Strong loam, dairy land	0 18 6	1 13 6	or	double.
5. Grazing and dairy land	1 2 0	2 0 0	or	double.
5)	2 12 6	5) 7 8 3		
Average expenditure per acre	0 10 6	1 9 8	or	3 times do.

Reckoning the labourer's wages at 10*s.* per week all the year round, or 26*l.* per annum, will enable us to contrast the proportion of land to each labourer, both in the state of pasture and of arable, as under :—

In Pasture.

	Expenditure in Wages per acre.	
	£. s. d.	
1. Down land	0 3 0	173 acres per man.
2. Light sandy land . . .	0 5 0	104 ,,
3. Stiff clay	0 4 0	130 ,,
4. Strong loam, dairy land . .	0 18 6	28 ,,
5. Grazing and dairy land . .	1 2 0	24 ,,
	5)	459
Average acreage to a man in pasture . . .		92 in round numbers.

The four million acres proposed to be broken up, must at present, then, in pasture employ 43,470 men.

In Arable.

	Expenditure in Wages per acre. £.	s.	d.			
1. Down land	0	19	3	and	27	acres per man.
2. Light sandy land . . .	1	0	0	„	26	„
3. Stiff clay	1	15	6	„	25	„
4. Strong dairy loam . . .	1	13	6	„	$25\frac{1}{5}$	„
5. Grazing and dairy farm . .	2	0	0	„	13	„
				5)	116	
Average acreage to a man in arable					$23\frac{1}{5}$	

Thus the same four million acres, converted into arable, would employ 174,000 men. The difference in favour of arable will be 130,530, as the additional number of men likely to obtain permanent employment by breaking up that extent; and this without reckoning anything whatever for the labour of draining, which would be about as follows. According to my estimates, three-fifths of the four millions of acres would require draining; and to do it in a substantial manner, as far as my experience has extended, will cost 4*l.* per acre very nearly, in manual labour. This would require the sum of 9,600,000*l.* to be expended, the whole of which would pass through the hands of the labourer. This work would employ 320,000 men for twelve months. In these estimates I have omitted the additional hands that would be required by the introduction of the plan of soiling, which would inevitably force its way into practice; so that, on the whole, I should not overstate the number of additional hands required, if I put them down at 200,000 men, who, with their families, would amount to 1,000,000. From calculation, then, I am led to believe that by accomplishing what I have proposed and shown to be practicable, we may easily provide food for 1,000,000 families, numbering at least 5,000,000 persons, and find constant employment for 200,000 additional labourers, *without greatly altering our present system of husbandry*—with profit to the landowners and occupiers—comfort and contentment to the labourer, and an immense benefit to the country, as well in providing additional food for the people, as by securing to the labourer himself a competency, the reward justly due to every tiller of the soil.

27th February, 1846.

XII.—*On Short-horn Cattle.* By John Wright.

The breed of short-horn cattle is fast spreading into all parts of the kingdom—into Scotland as well as into the milder climate of the midland and southern counties of England, where it has to compete in an especial manner with its rival, the Herefords.

To institute a comparison of the respective merits of the various breeds of cattle in the kingdom would require much time, and end in useless controversy; but if we examine closely the cows around London and other large towns, we find them to consist principally of short-horns, which is very strong evidence that they excel all other breeds in the property of giving milk.

It has been attempted to point out a difference between the Durhams, short-horns, and improved short-horns: these minute distinctions I will not attempt to define, nor will I stop to inquire how long the counties of Northumberland, Durham, Yorkshire, and Lincolnshire have had a breed of short-horned cattle; but certain it is that great pains were taken by Mr. Charles Colling, of Ketton, in the county of Durham, to select animals possessing feeding properties in a high degree, and under his auspices a race of animals was presented to us which may justly be entitled to the appellation of "improved short-horns;" and it is of this breed of cattle I wish more particularly to speak. They have been called the Durham breed and the Ketton breed: this appears to have arisen from the circumstance that there were two prints published of Mr. Charles Colling's ox that travelled for show, in one of which he is called the Durham ox, and in the other the Ketton ox. It should be remembered that some of the most important selections to improve this breed were made from herds on the Yorkshire side of the river Tees.

Sceptical persons there are who lay great emphasis on the want of improvement in the short-horns of the present day: this may with some degree of truth be admitted, if taken in comparison with the Ketton herd; but surely there is a manifest improvement in the general breed of short-horns throughout the kingdom, and a vast increase in numbers. At Mr. C. Colling's sale in 1810 few persons bought both male and female, so as to enable them to continue the same precise blood: consequently the purchasers of one animal only had to put him or her to such stock as he previously possessed, thereby improving the progeny of his own, but deteriorating that of the purchase; so that the produce was inferior to the original Ketton beast, and might require several judicious crosses with good animals to raise them to the original standard. It is a rare occurrence to find a healthy herd of pure and close descent from the Ketton breed. Assuming, then, that the short-horns have never equalled the perfection in which they

were presented to us by Mr. C. Colling, it behoves us to ascertain the means he used to accomplish so desirable an object, and to apply ourselves assiduously to follow his example.

A brief account of the Ketton herd of short-horns may be acceptable to those who never had the opportunity of seeing them. They were of great size and substance, with fine long hind quarters; the space from the hip to the rib was long, but the evils attendant on an extreme length in this part were counteracted by a broad back and high round ribs; the shoulders of the males were upright, and the knuckles or shoulder-points were large and coarse, but that defect was not so apparent in the females; the general contour or side-view was stately and imposing, but their great superiority consisted in their extraordinary inclination to fatten. On handling, the skin was very loose and pliant, and the feel under it was remarkably mellow and kind. Mr. C. Colling was distinguished above all other breeders of his day by a peculiarly fine discriminating touch, which enabled him to judge of the quality of the flesh and its tendency to fatten, to which, in connexion with good judgment in other respects, his superiority and success as a breeder were mainly attributable. The colour of the Ketton short-horn varied greatly—red, red and white, roan, and also white being found in the same kindred; and in all crosses of close affinity there was a great tendency to white. Many versions are given of this peculiarity, but the most probable one is the notorious fact that many of the best herds in the neighbourhood of Ketton were white, with red ears and red spots on their necks—viz. the Grilington, Barton, Barningham, Studley, &c. &c.; and to some of these the pedigrees of the Ketton herd are traced.

The original short-horns were a hardy, strong-constitutioned race of animals, as will be shown by stating that the writer's grandfather kept thirty cows, and had only one cowhouse, which held but two cows, and was occupied by those that had most recently calved, and they again were turned out to give place to others when newly calving; all the rest remained out during winter (be it remembered this was in a northern climate); those giving milk were kept during winter on hay in the meadow-field near the farm-house, and the remainder were kept in the meadows in different parts of the farm. There was only one fold-yard for five or six beasts; the whole of the young stock was reared out of doors, except young calves for a few months. The speed or quarter-ill was the only complaint they were subject to, which, from ten to eighteen months old, was frequently very fatal. This herd was closely descended from the Studley bull mentioned in the 'Herd-book:' many of them were large, fine-looking beasts, white, with red-spotted necks and red ears, and were excellent milkers.

In breeding short-horns, many persons whose opinions are en-

titled to great deference tell us that we should breed from such only as in themselves are perfect: this, however plausible in theory, will be found untenable in practice; for it may be asked, where do you find the first parents? A perfect and uniform-shaped beast, that lays its fat on every point in equal proportions, is highly desirable, so as to have no excess in one point to the disproportion of another; and in our endeavours to accomplish this desirable object, we should first become acquainted with the defective points in the female, and then select a male possessing those points in great perfection, and thereby ensure an improvement in their progeny: upon this principle hangs all the necessary knowledge for improving the shape of animals; but in all our selections we must never lose sight of *inclination to fatten*—the prominent feature of the short-horns. Improvements have often been anxiously sought for by crossing with other breeds, and many valuable specimens have been exhibited; but it may be asked, what breed is there that can improve the short-horn? I have seen many extraordinary animals from the cross with the West Highland Scot, but we do not find their offspring uniformly improving by each succeeding cross: there is great uncertainty in their progeny. The polled or Galloway Scot progresses with less variation in the produce, and continues to improve by subsequent crosses; but neither of them gives anything to the short-horn, though the short-horn adds much to them. Alloy being once introduced into any breed of animals will at certain times, and that too at very remote periods, show itself in their offspring. In a race-horse, how many crosses from a cart-mare would it require to produce a race of animals able to compete with the original thorough-bred one? and if you chanced to have one superior animal of that kind, who would dare to venture upon the next produce as being equal to the thorough-bred one?

When amendments of any kind are necessary, they may be found in some animals of the same species. The breeder on a small scale labours under a great disadvantage in this respect, as he may be supposed to keep only one bull; consequently all his cows are put to him indiscriminately: if not, he must be at great inconvenience, expense, and risk in sending them to other bulls. From the vast superiority of the Ketton short-horns, and the desire to perpetuate them with pure pedigrees, persons have been induced to breed from animals of close affinity of blood; and being conscious they could not resort to other families without employing inferior animals, and thereby impairing the properties of their own herd, various degrees of success have attended this course. There are several instances of superior animals bred in the closest affinity, whilst in a very great majority of cases the failure has been extensive and lamentable. No scientific explanation has been

given on this subject: we are left, therefore, to experience and observation to form our own conclusions upon it; and however satisfied each party may be, we possess no positive data to convince each other. The writer's opposition to this principle of breeding in and in proceeds from having witnessed so many serious losses in herds so allied, which, previous to the affinity of blood, were healthy and strong constitutioned. In the early short-horns no hoosing or cough, no delicacy of constitution was known; but as affinity of breeding progressed, a delicacy of constitution accompanied it. It has often been exultingly said that Comet was the finest bull of his day, and at the same time had the greatest affinity of blood of any animal we had: this is a truth which cannot be denied, but it might be the exception, and not the rule. It was notorious that the stock got by him out of cows that were strangers in blood was far superior to such as were more nearly akin. It will be remembered that Comet had a deformed shoulder: who can say that this did not proceed from close affinity in the parents? In the human frame it is a very common thing to see deformed shoulders proceed from disordered lungs.

In the short-horns of close affinity of blood, how many bulls do we find with lame shoulders, how many called cripples, and how many cripples in reality that never meet the public eye! We see no other race of animals with this defect, except those short-horns bred in and in. It has been said that this disease might arise through breeding from animals of bad constitution, and thus perpetuate the disease in their offspring; but when we find this disease originated and prevailing in animals of the same family, after repeated crossing in and in, though unknown in their ancestors, it is a fair presumption that the practice is inimical to the constitution. The injurious effects on the human system are well known; and although arguments on the opposite side have been adduced from the habits of wild animals and birds, yet there is enough in their manner of life, their migrations, and the usurpation of the strongest males, to account for an exception in their favour, if such really exists, which, however, is very doubtful. Mr. Mason, of Chilton, commenced breeding short-horns from the same parents as Mr. C. Colling, and for a certain period pursued it very successfully; but being deprived of the privilege of sending his cows to the Ketton bulls, he was constrained to use those of his own breeding, and the losses he sustained in his young stock were so great that at one time his show-cows were reduced to four: but by using the bull Jupiter, whose affinity of blood was supposed to be remote, he again became a successful breeder. Many other herds might be quoted in support of this opinion. Among the breeders of poultry, there are few who do not know that when the young ones become tender and difficult to rear, the remedy is found in

procuring a change of the male bird. Mr. William Clark, of Shincliff, miller, whose fighting-cocks were so notorious, continued to breed from his own kind till they lost their disposition to fight, but stood to be cut up without making any resistance, and were so reduced in size as to be under those weights required for the best prizes; but on obtaining a cross from Mr. Leighton, they again resumed their former courage and weights. In the numerous trials afforded him, he found those that were bred from a hen and her male chicken were the heaviest cocks and the best fighters; those from a cock and hen of the same brood the reverse. In pigs, the writer's experience was considerable in breeding from three or four sows at the same time, all descended from the same parents, boar and sow: these were put to the same boar for seven descents or generations; the result was, that in many instances they failed to breed, in others they bred few that lived; many of them were idiots—had not sense to suck; and when attempting to walk, they could not go straight. The last two sows of this breed were sent to other boars, and produced several litters of healthy pigs. In justice to the advocates of the in and in principle, it is but right to state that the *best* sow during the seven generations was one of the last descent—she was the only pig of that litter. She would not breed to her sire, but bred to a stranger in blood at the first trial. She possessed great substance and constitution, and was a very superior animal. Superior animals bred in that way may be occasionally met with; but this falls far short of proving the system to be good.

The proper size of animals is a subject on which we find a difference of opinion amongst men whose judgment and experience entitle them to great deference; but it would be well to consider the quality of the land, and the peculiarities of the situation with respect to shelter and elevation, before stock is selected for it. Short-horns are naturally of a large size, and some of the best specimens I have seen were large. There are many instances of their attaining great weights at early ages: I would instance the year 1828, when Mr. Grey, of Milfield Hill, sold six steers, three years old, that never tasted oil-cake, and averaged 84 stones: two of them weighed 90 stones. In November, 1803 or 1804, Mr. Brown, of Aldborough, sold eight steers at Darlington Fair—two of them a few weeks over three years old, and six of them under three years old—that averaged 84 stones. It was stated that they had not been kept in yards or houses the previous winter. At this period Swedish turnips were not much grown, and no turnip-cutters in use: they never tasted corn or oil-cake, and were brought up at the pail. Many other instances of great weights might be adduced. In advocating a moderately large size, it must be understood that it is the length, depth, and width, and not the

height of a beast, which constitute size: nothing is more objectionable than a high, overgrown animal. That animals do not increase in weight in exact proportion to the quantity of food they consume, has been frequently proved: those are the best animals that leave the most profit from a given quantity of food. The writer had at the same period three cows recently calved, which, for convenience of milking, were all kept in the same cowhouse; they were fed with straw and as many turnips as they could eat; the average weight through the year was 80 stones, 70 stones, and 60 stones each; the 80 stones cow and the 70 stones cow gave an equal quantity of milk, but that of the large cow was of better quality; the 60 stones cow gave more milk and of better quality than either of the two larger cows; the 80 stones cow and the 60 stones cow consumed an equal quantity of turnips, but the 70 stones cow ate one fourth more than either of the others. The 80 stones cow was a large, fine animal, with great inclination to fatten, and was an exception from the opinion that large animals are short-lived: she had fourteen bull-calves and three heifer-calves at single births, and was sold to the butcher within six weeks of her last calving for 26*l.*

In attempting to describe the properties which a good short-horn ought to possess, the difficulty would be lessened if they were all of one age and of one size; the relative proportions of each part might then be defined with precision and accuracy, so that by applying the scale the defects of symmetry would be immediately discovered: without such a test, we are left to form our own opinion from experience and observation of such animals as have met with general approbation.

In handling a beast, we proceed to put the hand on those parts usually called points, commencing at the rump, thence to the hip, loin, rib, crop, shoulder, neck-vein, fore-breast, back-breast, flank, twist, and udder or cod. Describing these several points so as to be carried into practice has always been found a most difficult undertaking, and for ever must remain so: it would be in vain, therefore, to suppose that these observations will be more successful.

The rump-bone, when the beast is in a lean state, should be about two inches off, and the upper part of it level or even with the under side of the tail. When the rump-bone lies near to the tail, it shows the smallest quantity of fat laid on that part; but the general dislike to this is proved by the name of "Tom Fool's Fat" being given to it. When narrow in this part, there is always a want of substance and lean flesh between that and the hip, and a part between them where the fat of the two points does not join together; whereas when the rump is farther from the tail, the fat is continued from it to the hip. The distance from the hip and rump should be long and full of lean flesh; the hips should be

wide, especially those of a female, which should be wider in proportion than those of the male. The shape of the hip is difficult to describe, but should be something like a round-pointed triangle with one end hanging downwards, and on putting the fingers on to the centre a hollow will be found. The loin should be flat and wide; and when lean, two knobs or pens should be felt, which, when fat, will be the base of two ribs, called false ribs, which connect the hip and rib together in mass. The part commonly called "the space" from the hip to the rib is generally recommended to be short; still it must be borne in mind that the beef on this part is of more value than any other: and if the loin be flat and wide, and the rib high and round, no ill effects will proceed from a moderate length of space, and it unquestionably gives that length and grandeur to the character of an animal which is very desirable: it is the want of a wide loin and round rib, and not the length of space, that causes gut. The rib should come well out of the back, and be broad, round, and deep. (It has been taught that the top of the back and underneath the belly should form two parallel lines, but there are few graziers who do not know the value of a good deep body, more especially in a Highland Scot.) On putting the fingers and thumb on each side of the rib, and drawing them together, the skin should be thick, pliant, and mellow, and the hand be filled with long soft hair; and the feel underneath should be smooth and pleasant. The sensation derived from a fine touch is delightful to an amateur breeder, but cannot be defined: few things denote a good hardy constitution more than a thick soft skin, full of long hair. Putting the finger and thumb on each side of the rib as above described is called "handling" in the North, but in the Midland and Southern counties it is generally called "quality." Whether that term had its origin at Smithfield we need not inquire, but certain it is that Mr. Charles Colling knew of no such word as applicable to inclination to fatten. "Quality" is frequently used to denote firmness of flesh, and sometimes it is misapplied, as in hardness of flesh, but seldom used to signify inclination to fatten: the mistake in this particular has done much harm to many herds of short-horns. Let handling and quality go together in a fat animal, and a good-bred short-horn will have *waxy* beef, under a loose, pliant hide, full of soft long hair; but in a poor beast, "handling" is the only test to discern the inclination to fatten. Handling is the most important subject we have to consider: it is the grand characteristic of a short-horn. Of what value would an animal be, possessed of perfect symmetry, if he could not be made fat without extraordinary keep? It has been said above, that it was Mr. Charles Colling's fine touch in this particular that enabled him to bring the Ketton short-horns to their unrivalled state of excellence:

its importance has led me to dwell upon it at some length; but it is impossible to describe the kindly *feel* which is conveyed to the senses by the *handling* of a first-rate short-horn; yet the knowledge of it is absolutely necessary for a breeder to possess before he can bring his herd to any high state of excellence. The next point under consideration is the crop, in the shape of which, width of the back, and roundness of the rib, but in a less degree, should be continued forward, so as to leave no hollow behind the shoulders. The shoulder on the outside should have a roll of fat from the lower to the upper part of it; the nearer to the top, the more closely it connects the crop and the collar in front of the shoulder together. In the anatomy of the shoulder, modern breeders have made great improvement on the Ketton short-horns by correcting the defect in the knuckle or shoulder-point, and by laying the top of the shoulder more snugly into the crop, and thereby filling up the hollow behind it. This is an important improvement, but it may be questioned whether the great attention that has been paid to this has not been attended by the neglect of some other more valuable parts, for we *now* seldom find those long hind quarters so peculiar to the Ketton short-horns. Shoulders should be rather wide at the top; that is, they should not lie close to nor be quite so high as the withers; for when they are narrow at the top, and *too* oblique in the shape, they never cover with fat over them properly, and the neck of such animals is often too low. Mr. Mason, of Chilton, whose attention was first drawn to this point, with his wonted skill succeeded to admiration: the prominent breasts and oblique shoulders of his beasts, on a side view, were perfect; but the shoulders were close and narrow at the top, and did not load with fat. The first evidence of this, of notoriety, was in the beautiful cow Gaudy (whose picture is to be seen in the first volume of the 'Herd-book'), who, when slaughtered, was *barely* covered in this point, although very fat in all other points.

The neck and head are not handling points; but I will briefly notice them before I turn to the lower part of the body: the neck should be thick, and tapering towards the head; a thin neck is strong evidence of a want of flesh and substance in other parts. There are various opinions on the shape of the head: some prefer it to be long and lean, whilst others approve of its being thick and short; but to be broad across the eyes, tapering considerably below them to the nostrils, which should be capacious, with a cream or flesh coloured muzzle, will be nearly correct; although it is but right to state that there are many well-bred short-horns with dark muzzles. This has been considered by many to be a recent introduction, through some inferior cross; but, without denying that, let it not be forgotten that some of the

early short-horns were not entirely free from it, although not very common; but the sire of Foljambe could not boast of much delicacy there. The horn has often been called a non-essential, and in some respects that may be true; yet it must be admitted that a small moist white or yellowish horn, coming well off the head with a graceful circle and with a downward tendency at the end in a female, and an inclination upwards in an ox, contributes much to the character and appearance of an animal, and denotes a feeding propensity. The eye has had its fashion at different periods: at one time the eye high and outstanding from the head, and at another time the sleepy eye sunk into the head; but these extremes have merged into the medium of a full, clear, and prominent eye, with a placid look. The neck-vein forms a collar in front of the shoulder, extending from the upper part of it down to the breast end, connecting the fat on the shoulder with the fat on the breast, thereby promoting a uniform covering of fat throughout every part of a beast, commencing at the rump, and proceeding along the back to the hip, loin, rib, crop, shoulder, and breast, without patch, or any one part having excess of fat beyond that of its neighbour. The breast should come prominently out from between the fore legs, and extend down to about two or three inches of the knee-joint, and its width should never be lost sight of. An animal with a *wide back and a wide breast* cannot fail to have substance, fore flanks, wide fore legs, and other indications of a strong and vigorous constitution. A wide and fat breast should extend itself through the fore legs towards the udder in rolls of fat. The flank should be full, and easily found by the unbent fingers, without having to lift up the flank or close the fingers to find the fat: it should drop into the fingers, as it were. The buttock is a part that is not handled as a fat point, but should not pass entirely unnoticed, although in the best-bred short-horns there is little occasion for caution against the black flesh in this part, which some other animals have; but a want of lean flesh is as great an evil as an excess of it: it is necessary, therefore, that there should be great fulness nearly as low as opposite the flank, tapering from thence to the hock: this fulness should be on the inside as well as the outside of the thigh, and give a full twist, lining the division between the hams with a continuous roll of fat to the next point under the belly.

Hitherto my observations have been confined to feeding propensities only, without any regard to the dairy. It is notorious, and much to their detriment, that many of the most superior short-horns do not possess that quality in an eminent degree. The annual loss to the breeder on each cow is very considerable, when we see that of two cows consuming an equal quantity of food, one gives six gallons of milk per day, and the other gives

two only, this loss in milk will require much gain in beef to compensate for it. Cows for the dairy require to be of the same shape, and possessed of the same feeding propensities, as have been attempted to be described above, with the addition of a well-shaped udder. When in full milk, the udder should be capacious and flesh-coloured, with paps standing square and at a distance from each other, the hind part to appear as if it proceeded from the twist; and it is the fore paps that give the most milk: the milk-veins under the belly should be large and full. There is no test to determine beforehand whether a cow will give good milk or bad, but it is at all times very essential to rear bulls out of cows that are descended from a tribe of good milkers.

Having given a general outline of all the points of a good short-horn, there is still the outward contour and character deserving of notice. On viewing an animal, all the points described above are brought to our sight at once, and we can almost determine upon their merits at sight, without the more unerring test of the fingers. The placid looks, the graceful head, neck, and horns, the straight top, the prominent breast, the snug-laid shoulders, the wide back and hips, the round ribs, the fine long quarters, the flowing silvery hair, the clean limbs, and great substance—all present themselves simultaneously, and give an impression that language cannot define. An artist, on looking at a painting, can instantly discern whether it is a highly-finished picture; but if called upon to describe its merits, he would, I presume, be at a loss for language to convey his feelings and judgment to an inexperienced person; and there is the same high finish in a good short-horn, attended with the same difficulty of explanation. Experience is universally allowed to be the best teacher; though, if we are left to our own experience alone, it will require a life-time of no short duration to become a proficient.

Romely, May 6, 1846.

XIII.—*Analyses of the Mineral Ingredients of the Hop.* By J. C. Nesbit, F.G.S., M.C.S.L., &c., of the Agricultural and Scientific School, Kennington, near London.

The hop, which is extensively cultivated in many parts of England, is well known as being employed to give a proper flavour to malt liquors, and to prevent them from running too quickly into acetous fermentation.

This plant (the Humulus lupulus of Linnæus) belongs to the natural Order Urticaceæ, the same order which includes among others the common nettle and the hemp.

It is a diœcious plant, some plants bearing male flowers, and others female flowers. The female flowers of the plant constitute the hops. The male hop is known in Kent as the wild hop or the blind hop, and is very generally eradicated from the hop-gardens, because its small flowers so soon wither away: they wither only however, after having prepared the pollen necessary to impregnate the female flowers. It has been found by experience very beneficial to encourage the growth of the wild hop in the vicinity of the hop-plantations, as when the female flowers are impregnated with the pollen from the males, they become much larger and furnish a greater weight of hops, of a more powerful bitter and more agreeable flavour.

The cultivation of the hop is one of the most important items in farming, in Kent, Sussex, and parts of Surrey, Hampshire, Herefordshire, and Worcestershire; and requires at the same time a greater capital per acre than any other crop. It seems, therefore, a matter of some surprise that no one has hitherto engaged in the analysis of the ashes of this plant, in order to discover the quality and weight of the mineral ingredients removed from the soil by the hop.

It is well known to all hop-farmers, that hops require more manure for their proper development than any other plant which they cultivate.

Being anxious, if possible, to render the cultivation of this plant less expensive, I undertook the analysis in our laboratory, of the mineral ingredients of the hop, of two varieties, and grown upon widely different geological formations. The first samples analysed were the produce of four hills of the Golding Hop, kindly furnished me by John M. Paine, Esq., of Farnham. Farnham itself is peculiarly situated just at the junction of the tertiary, chalk, and upper and lower green sand formations.

The land upon which these hops were grown has been long under cultivation. There is an artificial vegetable mould of about two feet in depth, resting upon a stratum of loam mixed with marl rubble, below which is the upper greensand, or firestone of geologists. This is an excellent stone for building; and between the interstices of the stones to a great depth, the finely comminuted portions of the upper soil appear to have been washed from time to time, and in their crevices the roots of the hop are always found to grow with much luxuriance.

Nearly the whole of the best description of hop-land at Farnham is of the above description.

The Golding Hop.

These hops were picked in September, 1845, and, together with the leaves and bine, were sent to me in the latter end of that

month; the hops of the four hills, dried, weighed 2 lbs.; the dried leaves, $9\frac{3}{8}$ oz.; and the dried bine, 1 lb. $2\frac{1}{2}$ oz.

1.—*Analysis of the Ashes of the Hop.**

The 2 lbs. of hops, when dried at a steam heat, lost 3 oz. of moisture, and left 1 lb. 13 oz. of dry hops.

The dry hops were burned to ashes in a large earthen crucible, and furnished 1282 grs. of ashes, being at the rate of $9\frac{9}{10}$ per cent. These ashes were analysed in the usual manner, and every hundred parts contained as follows:—

1.—Ashes of the Hop.

Silica (or pure sand)	20·95
Chloride of Sodium (common salt)	7·05
Chloride of Potassium	1·63
Potash	24·50
Lime	15·56
Magnesia	5·63
Sulphuric Acid (oil of vitriol)	5·27
Phosphoric Acid	9·54
Phosphate of Iron	7·26
Carbonic Acid	2·61
	100·00

2.—*Analysis of the Ashes of the Leaves of the Hop Plant.*

The $9\frac{3}{8}$ oz. of leaves, dried at a steam heat, lost $1\frac{1}{8}$ oz. of moisture, and left $8\frac{1}{4}$ oz. of dried leaves.

The dried leaves, burned to ashes as before, gave 572 grs., being at the rate of $16\frac{1}{5}$ per cent.

The ashes were of the following composition in the hundred parts:—

Ashes of the Leaves of the Hop Plant.

Silica	10·14
Chloride of Sodium (common salt)	7·92
Soda	0·32
Potash	12·48
Lime	41·46
Magnesia	1·99
Sulphuric Acid	4·20
Phosphoric Acid	2·02
Phosphate of Iron	2·93
Carbonic Acid	16·54
	100·00

3.—*Analysis of the Ashes of the Hop Bine, or Stalk.*

The 1 lb. $2\frac{1}{2}$ oz. of the bine, dried at a steam-heat, lost $1\frac{7}{8}$ oz. of moisture, and left 1 lb. $0\frac{5}{8}$ oz. of dry bine.

The dry bine burned, gave 353 grs. of ashes, being at the rate of nearly 5 per cent.

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* In the following tables the loss is previously deducted.

The ashes gave the following results in the hundred parts:—

ASHES of the BINE of the HOP.

Silica	4·64
Chloride of Sodium (common salt) . . .	4·95
Chloride of Potassium	7·38
Potash	18·62
Lime	29·59
Magnesia	3·15
Sulphuric Acid	2·63
Phosphoric Acid	5·22
Phosphate of Iron	0·31
Carbonic Acid	23·51
	100·00

4.—*Composition and per centage of the Ashes separated from the Carbonic Acid.*

The carbonic acid combined with the lime, &c. in the ashes, was produced during the burning of the plant, by the oxidation of the carbon of the vegetable matter.

It is therefore not a mineral ingredient of the soil; and in order to arrive at the real per centage of inorganic matter, it is necessary to withdraw the carbonic acid from the foregoing tables. This has been done in the following tables:—

TABLE 1.—QUANTITY per Cent. of MINERAL INGREDIENTS in the HOP, Leaves of HOP, and BINE, dried at the Temperature of Boiling Water.

	Hop.	Leaves.	Bine.
Per Cent. . .	9·87	13·6	3·74

TABLE 2.—COMPOSITION in One Hundred Parts of the INORGANIC MATTER.

	Hop.	Leaves.	Bine.
Silica	21·50	12·14	6·07
Chloride of Sodium . .	7·24	9·49	6·47
Chloride of Potassium . .	1·67	..	9·64
Soda	..	0·39	..
Potash	25·18	14·95	24·35
Lime	15·98	49·67	38·73
Magnesia . . .	5·77	2·39	4·10
Sulphuric Acid . .	5·41	5·04	3·44
Phosphoric Acid . .	9·80	2·42	6·80
Phosphate of Iron . .	7·45	3·51	0·40
	100·00	100·00	100·00

5.—*Quantity of inorganic Matter taken from the Land by four Hills of Farnham Hops.*

In order to obtain practical benefit from the foregoing analyses, it will be necessary, in the next place, to ascertain the whole amount of inorganic matter removed by the four hills of hops, and likewise the amounts of the separate ingredients.

The following table gives us the actual weight, in *grains Troy,*

of the various ingredients removed from the soil by four hills of hops.

Actual Weight of Mineral Ingredients removed from the Soil by Four Hills of Hops.

	Hops.	Leaves.	Bine.
Silica	268·11	59·24	16·63
Chloride of Sodium . .	90·28	46·31	17·73
Chloride of Potassium . .	20·82	..	26·41
Soda	..	1·90	..
Potash	314·00	72·96	66·72
Lime	199·27	242·39	106·12
Magnesia . . .	71·95	11·66	11·23
Sulphuric Acid . .	67·46	24·60	9·43
Phosphoric Acid . .	122·21	11·81	18·63
Phosphate of Iron . .	92·90	17·13	1·10
Total weight . .	1247·00	488·00	274·00

6.—*Amount of Mineral Ingredients removed from the Soil by an Acre of Hops.*

The number of hills of hops to an acre varies in different localities. In some places 1000, in others 1260, in others 1440 hills go to the acre.

In the present instance I believe about 1000 to be the number of hills contained in an acre.

Therefore, by multiplying the numbers in the preceding table by 250, we shall have the actual weights of the various inorganic ingredients of the soil removed from an acre of land by the hop.

For the convenience of agriculturists, I give in the following table these weights in pounds and ounces avoirdupois.

Amount of various Mineral Ingredients removed from an Acre of Land by the Farnham Hop.

	500 lbs. of Hops.		146½ lbs. of Leaves.		289 lbs. of Bine.		Total in Hops, Leaves, & Bine.	
	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.
Silica . . .	9	9	2	2	0	9½	12	4½
Chloride of Sodium .	3	3½	1	10	0	10	5	7½
Chloride of Potassium .	0	12	0	0	0	15	1	11
Soda	0	0	0	1	0	0	0	1
Potash . . .	11	3½	2	10	2	6	16	3½
Lime . . .	7	1¼	8	10	3	13	19	8¼
Magnesia . . .	2	9	0	6	0	6½	3	5½
Sulphuric Acid . .	2	6¾	0	14	0	5¼	3	10
Phosphoric Acid . .	4	6	0	7	0	9½	5	6½
Phosphate of Iron . .	3	5	0	10	0	0¾	3	15¾
Sum total . . .	44	8	17	6	9	11½	71	9½

The Yellow Grape Hop.

The grape hop is of a different species to the Golding, and generally produces a greater amount of crop per acre. These hops were sent by Mr. Kipping of Hadlow, Kent, and were grown on the weald clay, on a soil manured almost to the fullest extent that the land would bear. Occasionally from 25 cwt. to 30 cwt. per acre of hops have been grown on the same land. The following analyses were performed, at my own request, in our laboratory, by my pupil Mr. James Allen of Howberry, near Dartford, Kent.

The hops were picked in September, 1845. They weighed 4 lb. 2 oz.; the leaves 14½ oz.; and the bine 2 lbs. 12 oz.

Analysis of the Ashes of the Grape Hop.

The 4 lbs. 2 oz. of hops, when dried at a steam heat, lost nearly 11½ oz. of moisture and left 3 lb. 6½ oz. of dry hops.

The dry hops burned to ashes furnished 4649 grs., being at the rate of 19·4 per cent.

These ashes on analysis gave as follows:—

Silica (or pure sand)	20·40
Chloride of Sodium (common salt)	2·60
Chloride of Potassium	1·80
Potash	15·20
Lime	19·40
Magnesia	5·00
Sulphuric Acid (oil of vitriol)	3·40
Phosphoric Acid	4·30
Phosphate of Iron	5·55
Carbonic Acid	2·75
Manganese	1·30
Sand and Charcoal	16·40
Loss*	1·9

Analysis of the Grape Hop, with the Sand, Charcoal, and loss deducted. Per Centage of Ash, 15·8.

Silica (or pure sand)	24·96
Chloride of Sodium (common salt)	3·18
Chloride of Potassium	2·21
Potash	18·61
Lime	23·75
Magnesia	6·13
Sulphuric Acid (oil of vitriol)	4·16
Phosphoric Acid	5·26
Phosphate of Iron	6·79
Carbonic Acid	3·36
Manganese	1·59

* Fluorine was detected in the ashes of both samples of the hop.—J. C. N.

Analysis of the Ashes of the Leaves of the Grape Hop.

The $14\frac{1}{2}$ oz. of leaves, dried at a steam-heat, lost $1\frac{9}{10}$ oz. of moisture, and left 12 $\frac{6}{10}$ oz. of dried leaves.

The dried leaves, burned to ashes as before, gave 1475 grs. of mineral matter, being at the rate of 26·8 per cent.

The ashes were of the following composition in the hundred parts:—

	grs.
Silica (or pure sand)	19·00
Chloride of Sodium (common salt)	4·30
Soda	2·15
Potash	4·80
Lime	30·25
Magnesia	5·85
Sulphuric Acid (oil of vitriol)	3·40
Phosphoric Acid	3·45
Phosphate of Iron	·50
Carbonic Acid	20·00
Sand and Charcoal	5·25
Loss	1·05

ANALYSIS of the LEAVES of the GRAPE HOP, with Sand, Charcoal, and Loss deducted.
Per Centage of Ash, 25·11.

Silica (or pure sand)	20·38
Chloride of Sodium (common salt)	4·58
Soda	2·29
Potash	5·13
Lime	32·28
Magnesia	6·24
Sulphuric Acid (oil of vitriol)	3·63
Phosphoric Acid	3·68
Phosphate of Iron	·54
Carbonic Acid	21·25

Analysis of the Bine or Stalk of the Grape Hop.

The 2 lb. 12 oz. of bine, dried at a steam heat, lost $4\frac{3}{5}$ oz. of moisture, leaving 2 lb. $7\frac{2}{5}$ oz. of dry bine.

The dried bine burnt gave 918 grs. of ash, being at the rate of 5·3 grs. per cent.

The ashes gave the following results in 100 parts:—

Silica (or pure sand)	5·50
Chloride of Sodium (common salt)	9·70
Soda	2·25
Potash	12·60
Lime	16·90
Magnesia	12·25
Sulphuric Acid	3·05
Phosphoric Acid	7·90
Phosphate of Iron	2·00
Phosphate of Alumina	1·50
Carbonic Acid	23·50
Charcoal	2·00
Manganese	a trace
Loss	·85

ANALYSIS of the BINE or STALK of the GRAPE HOP, with Charcoal and Loss deducted.
Per Centage of Ash, 5·1.

Silica (or pure sand)	5·66
Chloride of Sodium (common salt)	9·98
Soda	2·32
Potash	12·97
Lime	17·39
Magnesia	12·61
Sulphuric Acid	3·14
Phosphoric Acid	8·14
Phosphate of Iron	2·06
Phosphate of Alumina	1·55
Carbonic Acid	24·18
Manganese	a trace

Composition and Per Centage of the Ashes separated from the Carbonic Acid.

REAL QUANTITY per Cent. of MINERAL INGREDIENTS in the HOP, LEAVES of the HOP, and BINE, dried at the Temperature of Boiling Water, found by deducting Carbonic Acid, Water, and Loss.

	Hop.	Leaves.	Bine.
Per Cent.	15·3	19·7	3·9

COMPOSITION in One Hundred Parts of the INORGANIC MATTER.

	Hops.	Leaves.	Bine.
Silica	25·83	25·87	7·46
Chloride of Sodium	3·29	5·82	13·16
Chloride of Potassium	2·28	..	..
Soda	..	2·93	3·06
Potash	19·25	6·52	17·11
Lime	24·58	40·99	22·81
Magnesia	6·34	7.92	16·64
Sulphuric Acid	4·31	4·60	4·15
Phosphoric Acid	5·44	4·67	10·74
Phosphate of Iron	7·03	·68	2·72
Phosphate of Alumina	..	..	2·15
Manganese	1·65	..	a trace

Quantity of Inorganic Matter taken from the Land by three Hills of Grape Hops.

The following table gives us the actual weight in *grains Troy* of the various ingredients removed from the soil by three hills of grape hops :—

ACTUAL WEIGHT of MINERAL INGREDIENTS removed from the Soil by three Hills of Grape Hops.

	Hops.	Leaves.	Bine.
Silica	947·96	281·21	50·43
Chloride of Sodium	117·45	63·26	88·97
Chloride of Potassium	82·39	..	..
Soda	..	31·85	20·68
Potash	706·47	70·87	115·67
Lime	902·08	445·56	154·19
Magnesia	232·67	86·09	112·48
Sulphuric Acid	158·17	50·01	28·06
Phosphoric Acid	199·64	50·76	72·61
Phosphate of Iron	258·01	7·39	18·38
Phosphate of Alumina	..	..	14·53
Manganese	60·56	..	a trace.
Total	3665·40	1087·00	676·00

Amount of Mineral Ingredients removed from the Soil by an Acre of Grape Hops.

In the present instance I believe about 1260 to be the number of hills contained in an acre.

Therefore, by multiplying the numbers in the preceding table by 420, we shall have the actual weights of the various inorganic ingredients of the soil removed from an acre of land by the hop.

For the convenience of agriculturists, I give in the following table these weights in pounds and ounces avoirdupois :—

AMOUNT of various MINERAL INGREDIENTS removed from an Acre of Land by the GRAPE HOP.

	1732 lbs. of Hops.		380 lbs. of Leaves.		1155 lbs. 12 oz. of Bine.		Total in Hops, Leaves, & Bine.	
	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.
Silica	56	14¾	16	14	3	0	76	12¾
Chloride of Sodium	7	0	3	14	5	5	16	3
Chloride of Potassium	4	15	..		..		4	15
Soda	..		1	14	1	4	3	2
Potash	42	6¼	4	4	6	15	53	9¼
Lime	54	1½	26	11	9	4	90	0½
Magnesia	13	15	5	2	6	12	25	13
Sulphuric Acid	9	7½	3	0	1	11	14	2½
Phosphoric Acid	11	15½	3	0	4	5½	19	5
Phosphate of Iron	15	7½	0	7	1	1½	17	0
Phosphate of Alumina	..		..			14		14
Manganese	3	10	..		..		3	10
Sum total	219	13	65	2	40	8	325	7

It will be seen from the preceding tables that a large amount of inorganic or mineral matter is removed annually from the soil by the hop. As the produce is almost wholly exported from the farm, it must be evident that unless the mineral matter is replaced, the richest soil would eventually be impoverished by the growth of this plant. This undoubtedly is one of the chief causes of the necessity of manuring this plant so highly.

The amount of mineral matter taken by the two species of hop varies considerably, but we must consider the Farnham hop to have taken from the land rather under the mark than over. According to the nature of the soil will be the necessity of applying one or all of the mineral ingredients enumerated; but potash, which in both seems to be taken out in nearly the same quantity for the same amount of crop per acre, is one of the most important ingredients, because the most scarce. Lime ought to be of service to the hops, as it is not only itself a necessary ingredient, but will likewise assist in the liberation of potash and silica from the insoluble silicates of the soil.

From the examination of various samples of hops, I am led to believe that the finer samples of hops require more potash than the coarser, and that the potash is replaced in the coarser hops by lime. Wood-ashes should certainly be of benefit to hops, as may be perceived at once from the following analysis of the common wood-ashes of the district of Farnham, for which (together with the two following) I am indebted to my pupil Mr. James Allen:

ANALYSIS of WOOD ASHES from Farnham.

	Wood Ashes.
Silica	4·25
Sand	10·00
Charcoal	·35
Lime	29·05
Magnesia	6·65
Potash	7·55
Soda	4·89
Chloride of Sodium	·80
Sulphuric Acid	3·25
Phosphoric Acid	4·70
Carbonic Acid	25·00
Phosphate of Iron	2·50
Phosphate of Alumina	·50
Manganese	a trace.
ALLEN.	99·40

Peat-ashes might, with the addition of some salt of potash, also be used with advantage.

ANALYSIS of PEAT ASHES from Farnham.

	Peat Ashes.
Silica	5·50
Sand	46·10
Charcoal	16·85
Lime	5·35
Magnesia	·10
Chloride of Sodium	·40
Chloride of Potassium	·60
Sulphuric Acid	3·25
Phosphoric Acid	·60
Carbonic Acid	2·50
Oxide of Iron	13·50
Alumina	4·40
ALLEN	99·15

The spent hops of the brewer have been proposed as a useful manure for hops. Irrespective of their organic matter they will also do good from their mineral ingredients. I subjoin an analysis of spent hops, from the brewery of Mr. Godden, of Maidstone, Kent. As might have been expected, the chief of the potash and other soluble ingredients have been washed away.

ANALYSIS of the MINERAL INGREDIENTS of Spent Hops.—The Spent Hops gave 10·4 per cent. of Ashes.

Sand and charcoal	21·80
Silica (soluble sand)	27·10
Chloride of sodium (common salt)	2·95
Chloride of potassium	0·70
Potash	1·45
Lime	23·70
Magnesia	2·75
Sulphuric acid	3·05
Phosphoric acid	4·10
Phosphate of iron	2·50
Carbonic acid	9·00
Manganese	a trace.
	99·10

The following observations will show the large amount of common manures necessary to supply the potash to an acre of hops:—

The average quantity of potash contained in guano is 3 lb. per cwt.

The straw of wheat contains on an average 5 per cent. of ashes, and every 100 lbs. of the ashes contain about 13 lbs. of potash.

Farm-yard dung contains on an average 7 per cent. of mineral ingredients. These contain about 3½ per cent. of potash.

The following table, which gives us the weights of different manures necessary to furnish 17 lbs. of potash to an acre of land, will make it probable that the large quantity of potash taken out

of the land by the hop, is the main reason for the necessity of manuring this plant so highly:—

7.—Quantity of Guano, Farm-Yard Dung, or Wheat Straw, necessary to furnish the 17 lbs. of Potash taken from the Soil by the Acre of Farnham Hops.

Hops, leaves, and bine of one acre of hops, containing 500 lbs. hops, 146½ lbs. leaves, 289 lbs. bine.	Guano.	Wheat straw.	Farm-yard dung.
935½ lbs.	7 cwt.	23 cwt.	61 cwt.

It is evident, from the foregoing table, that though 2 cwt. of guano are amply sufficient to supply the acre of hops with its phosphates, yet that it requires 7 cwt. to supply the potash. Consequently the 5 cwt. of guano might have been replaced by a cheaper manure destitute of phosphates, but containing 12½ lbs. of potash.

Hitherto I have spoken as if the hops, leaves, and bine of the acre of Farnhams were of the usual or average weight. But this was not the case. Owing to the unkindly weather the yield was very deficient. It is no uncommon thing in some districts to grow a ton of hops an acre. We will suppose a farmer to grow a ton of hops per acre, and that the mineral ingredients of the hop are in the same proportion as in those which were analysed.

We will suppose that the bine and leaves were double in quantity, but containing the same per cent. of inorganic matter as the others. This would give us 64 lbs. removed per acre by the Golding hop, while the Grape hop would remove about 75 lbs. per ton, though perhaps 64 lbs. might be taken as the average.

The following table will then show us the weight of guano, wheat straw, or farm-yard dung, per acre, necessary to be put on the land, to replace the potash withdrawn by the hops, bine, and leaves:—

8. Quantity of Guano, Wheat Straw, or Farm-Yard Dung annually necessary to replace the 64 lbs. of Potash taken from an Acre of Land by a Ton of Hops, with Bine and Leaves corresponding.

Hops, leaves, and bine of an acre of hops, containing 2240 lbs. of hops, 293 lbs. of leaves, 578 lbs. of bine.	Guano.	Wheat straw.	Farm-yard dung.
3111 lbs.	1 ton 5 cwt.	4 tons 7 cwt.	11 tons 13 cwt.

Now as the whole of the above methods of furnishing the necessary amount of potash are enormously expensive, we are necessitated to look to other and cheaper sources for this valuable substance.

Several salts of potash are well known in commerce, and likewise to the agriculturist. Nitrate of potash or saltpetre is one, and common pearlash is another.

Saltpetre contains about 47 per cent. of potash, and pearlash about 68 per cent. By calculation, therefore, we find that 64 lbs. of potash taken from the land by a crop of hops would be replaced by 136 lbs. of saltpetre, at a cost of about 32*s*., or by 94 lbs. of pearlash, at a cost of about 33*s*.

The weights of saltpetre or pearlash given above would supply the deficiency of potash, supposing the whole crop, including bine, leaves, and hops, were removed from the land. But if the bine and leaves be allowed to rot on the ground, about *one-sixth* less than the preceding amounts would be sufficient. The impropriety therefore of removing the bine, &c. from the land, as is too often the case, is very apparent.

One of the most important points to be deduced from these analyses is the preparation at a reasonable expense, of a manure which shall contain all the necessary mineral ingredients for the growth of the hop. Being engaged in the analyses of various other samples of the hop, I am now unwilling to offer as perfect any manure for the hop until the comparison of different varieties shall have shown that the hops in divers localities agree in the per centage of their various constituents.

It will be seen by reference to the analyses, that besides potash, the hops contain phosphoric acid, lime, magnesia, common salt, and silica. About 3 cwt. of guano would supply the necessary amount of phosphates. The chloride of sodium would be amply supplied by 1 cwt. of common salt. Lime and magnesia are doubtless found in sufficient quantities in the land, or if not they can easily be supplied. The silica, perhaps, may be found in sufficient quantities in the land, though it might be better to supply both silica and potash together, in the shape of silicate of potash. This compound, however, is not at present an article of commerce, but there is a probability that it will soon be manufactured on a large scale. The sulphuric acid can be supplied by gypsum.

Either of the following mixtures might be worth trial for promoting the growth of the hop :—

No. 1.—Manure for an Acre of Hops.

	s.	*d.*		£.	*s.*	*d.*
3 cwt. guano, at	8	0	per cwt.	1	4	0
1 cwt. common salt, at	1	0	,,	0	1	0
1½ cwt. saltpetre, or 1½ cwt. silicate of potash at	26	6	,,	1	19	9
1½ cwt. gypsum	1	6	,,	0	0	9
Cost per acre				3	5	6

No. 2.—Manure for an Acre of Hops.

	s.	d.		£.	s.	d.
1 cwt. guano, at . .	8	0	per cwt. . .	0	8	0
1½ cwt. superphospate of lime, at . . .	8	6	,, . .	0	12	9
1 cwt. common salt . .	1	0	,, . .	0	1	0
1 cwt. pearlash, or equal value of silicate of potash	38	0	,, . .	1	18	0
½ cwt. gypsum . .	1	6	,, . .	0	0	9
Cost per acre				3	0	6

Experience, however, alone can prove whether the above manures are adapted for the end proposed, and they are proposed therefore as subjects of experiment merely.

Some other interesting points respecting the organic portions of the hop, the use of organic matters, as shoddy, rags, &c., and the analyses and relative values of the various manures which are considered beneficial to its growth, will be made public as soon as the necessary analyses are completed.

XIV.—*On the Advantages of One-horse Carts over Waggons.* By P. Love.

In treating of this subject, I believe the best way will be to begin with the first work that takes place on the farm, and pursue it through the whole year, proving the advantages of carts over waggons in each department of work.

As manure is generally the first thing a good farmer begins to apply, I will begin with that.

Four men, being the number that can get room round a cart to fill without being in each other's way, are the number that will be the most profitably employed at that work, because there will be the least horse-time sacrificed in standing while filling.

To find the number of horses and drivers that are requisite to keep a given number of fillers employed, only requires measuring the distance between the heaps and field in furlongs, then multiplying the furlongs by five, and dividing by the number of minutes occupied in filling a load, which will give the number of horses and drivers that will be required to keep all in full employment, but there must be a horse loading and one emptying, besides the number found by the above rule. The reason that the above rule will do is, a horse travelling at the rate of three miles an hour will go a furlong and retrace his steps in five minutes; therefore multiplying the furlongs by five, gives the number of minutes a horse will take to go and return to be loaded again; consequently the time taken for one revolution of a horse divided by the time taken to fill a load, will give the number of loads

that can be filled before the arrival of the first cart to be filled again. For instance, to cart manure at a distance of three furlongs, three fillers will require two horses and one driver, taking in all four horses, two drivers, and one emptier, to keep them employed; because they will take $6\frac{2}{3}$ minutes to fill the cart, the horse will take fifteen minutes to go and return, and the tipper or emptier will take five minutes to his part of the work; making in all $26\frac{2}{3}$ minutes to go one revolution, at the end of which time the fillers will have filled four loads, and the first horse will have returned in time for filling again; and so on until done.

It will be observed, that when four men (who will take just five minutes to fill a cubic yard of farm-yard dung) are employed, it will just require an extra horse and driver for every furlong of distance it is to be drawn.

At great distances a horse may be nearly gained by unyoking the horses from the empty carts and putting them into the full ones; to do this will take a man and the driver two minutes, so that two minutes of the time that the horse would have been on his journey occupied in the changing, in which time the horse would have gone about one-third revolution of a furlong; still there is a gain by so doing: although I must say I do not like it, except when obliged through necessity, for by standing a few minutes and getting a bite of hay or chaff and bran, the horse's spirits will revive, and he will offer no temptation for the use of the whip.

The quantity of farm yard manure (taken in the solid state as it is left in the yard by the treading of the cattle) that a one-horse cart will hold is 1 cubic yard, which will measure about $1\frac{1}{2}$ cubic yards after being thrown on the cart, and will weigh from 16 to 20 cwt., according to the quality.

If two-horse carts are employed they will not hold more than $1\frac{1}{2}$ solid yard, which will measure about $2\frac{1}{4}$ yards when thrown on the cart, and will weigh from 24 to 30 cwt. according to shortness, &c., besides the cart, which generally weighs about 12 cwt.; making a total of about 2 tons, or equal to 1 ton per horse.

A good one-horse cart will not weigh more than 6 cwt., which with dung at 18 cwt., will make a total of 24 cwt., per horse, which a single horse will draw easier than two horses will draw 2 tons in a cart, because they never draw alike—one drawing too much, while the other is doing nothing; besides the great weight having a greater tendency to cut into and consolidate the soil to a greater depth than the light loads, to the injury of the succeeding crop; also the difficulty of driving two horses in a cart, so as to keep the road from being cut into deep ruts by the horses continually going in the same track. Whereas with one horse, by making the boys lead the horses so as to make a wheel-track,

about eighteen inches wide, which is easily done by driving each alternate horse first on one side then on the other; by attending to this for a while at first it will soon get as smooth as a turnpike-road. If there are any steep hills a trace-horse ought to be used, but return as soon as at the top to help another horse, so as to serve as an assistant to them all in succession.

It is evident that there is a great loss of horse-labour with two-horse carts; first, in their not being able to draw so much out per horse, for as three one-horse carts will take out as much as two double-horse carts, there is a loss of one horse in four, equal to 1*s.* per yard; against which must be set an extra driver, costing 6*d.* per day, equal to 2*d.* per yard; leaving 10*d.* per horse in favour of one-horse carts, or about one-fourth.

Secondly, there is a great sacrifice of time in tipping the load, which will be increased from five minutes (the time taken in tipping a one-horse load) to seven minutes and a half, during which time two horses will be kept waiting, which is equal to fifteen minutes of one horse, causing a loss of ten minutes of one horse in the tipping of the extra cubic yard of manure, which ought only to be two-and-a-half, at the same ratio as the time occupied in tipping a yard, making a clear loss of seven minutes and a half, in which time the horse would have travelled back 3 furlongs.

Perhaps this disadvantage will be better illustrated by the following table, taking the distance to be travelled in furlongs, and counting each boy driving as the fourth of a man tipping, and a man's wages at 2*s.* per day, and the expense of each horse at 3*s.* a day, of nine hours.

	One-horse Carts.	Two-horse Carts.	One-horse Carts.	Two-horse Carts.	One-horse Carts.	Two-horse Carts.
Distance in Furlongs	3	3	3	3	7	7
Time of travelling a revolution	15	15	15	15	35	35
Number of Horses	3	3	5	5	9	9
Number of Carts	3	2	5	3	9	5
Men filling the Carts	2	2	4	4	4	4
Time of filling	10	15	5	7½	5	7½
Men tipping and driving	1¼	1	1¾	1¼	2¾	1¾
Time of tipping	5	7½	5	7½	5	7½
Total Time taken to each revolution	30	37½	25	30	45	50
Number of Loads drawn	54	29	108	54	108	54
Number of Yards drawn	54	43½	108	81	108	81
	s. *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*
Expense of Horses	9 0	9 0	15 0	15 0	27 0	27 0
Expense of Men	6 6	6 0	11 6	10 6	13 6	11 6
Total Day's Expense	15 6	15 0	26 6	25 6	40 6	38 6
Expense of carting thirty yards	8 7¼	10 2¾	7 4¼	9 5	11 3	14 3
Saving by one-horse carts per acre	1 7½	..	2 0¾	...	3 0	..

It will be seen by the above table that the greater the distance the greater the advantage of one-horse carts over two-horse carts; as is seen by the table where the distance is 7 furlongs, the advantage of one-horse carts over two-horse carts is more than a fourth in the expense of putting 30 yards of manure on an acre, or on two acres if you choose to put only 15 yards per acre; which sufficiently proves the advantage of one-horse carts over two-horse carts at this sort of work.*

The next work that will command our notice will be the drawing or the carrying of the hay-crop together: the better way to illustrate this will be to take the dimensions of a proper harvest, or carrying cart. The dimensions of those carts vary from 11 to 15 feet long by 6 feet wide; the average weight, from 5 to 9 cwt., according to the size and material of which they are made. Wherever good larch is to be got they should be made of it, as it combines strength with lightness to a greater degree than any other timber. Not being an advocate for the largest size of harvest-cart I will take that size which meets my own views, namely, 12 feet long by 6 feet wide, which will stand about 3 feet above the ground; therefore, with a load $10\frac{1}{2}$ feet high from the ground, will have 20 cubic yards of hay on it, weighing from 16 to 20 cwt., or a total of 25 cwt., which is a fair load for one horse on the road or on the field, where the land is not too hilly; but where there are very steep hills (such as I have got) it is necessary to have a trace-horse. On farms that are entirely hilly it would be better to have very light carts, and use only one horse at the ascents.

Our waggons are about 12 feet long, but for carrying they are generally increased by putting on a frame-work, to 17 feet long, 5 feet wide, and 6 feet high from the ground to the top of the rail, and weigh from 20 to 28 cwt., upon which there can be built about 28 cubic yards, weighing from 22 to 28 cwt., making a total of about 48 cwt., the waggon being about half the gross weight; whereas with carts, the cart would be about one-fourth of the gross weight. The waggons requiring two horses to draw them, each horse draws only $12\frac{1}{2}$ cwt. of hay, although having as much gross weight to draw as horses in carts, namely, 25 cwt.; therefore, four horses with two waggons would bring home about 50 cwt. of hay; while three horses with carts, as before mentioned, would bring 54 cwt. of hay, their total loads being 75 cwt.; while the total gross waggon loads would be about 96 cwt., or 24 cwt. per horse; being only 1 cwt. less weight than that of the cart horses, which proves that for this description of work, carts give a saving of one-fourth in horse-labour.

* The saving would be yet greater if one-horse carts were compared with the heavy dung-carts drawn by three horses, often used in the south of England.—PH. PUSEY.

I have heard it stated by some people that there is a disadvantage in carts in the stackyard to the pitchers, or emptiers, on account of their being lower than waggons. But let us examine this supposed disadvantage. A cart is loaded with hay $7\frac{1}{2}$ feet above the body, and calculating the average height at half the height of hay in both instances, the average height on a cart will be $3\frac{3}{4}$ feet, which, with 3 feet from the bed of the cart to the ground, will make $6\frac{3}{4}$ feet from the ground. The waggon being loaded 8 feet high from the body, the average will be 4 feet, and 6 feet for height of body makes a total of 10 feet, being $3\frac{1}{4}$ feet in favour of waggons in building a rick; but there will be the same disadvantage against them in the field. In the commencement of the stack there is a clear loss of labour in being obliged first to pitch the hay upon a high platform, whether it be in the shape of a cart or waggon in the field, and then throw it down again in the rickyard; therefore, the waggon being the highest, there is the greatest waste of manual labour in this way with waggons; consequently, the extra height of waggons is disadvantageous in the beginning of a stack, and advantageous after it gets high; in carts, the advantages are in the beginning and the disadvantages in the finishing of the stack, being, I believe, about on a par as to manual labour, but carts being one-fourth more economical than waggons as to horse labour.

Some people, who do not understand the working of carts, fancy that they will not do upon hilly farms, but I am convinced that carts can be used where waggons could not, by applying a rest and slipper either behind or before, as suits the going up hill or down: in going up or down hill the rule is to bring the body of the cart to a level, so that the loader will have no difficulty in building, more than he would have on a level field, being able therefore to keep it at a fair balance; so that whenever they come to the level, and the load is laid upon the horse, it will not be too light nor too heavy on his back.

All very hilly fields should be ploughed at an angle of about forty-five degrees to their base; so that when the horses are going up hill the furrow-slice will be turned down hill, and when coming down the furrow will be turned against the hill, which will give the horses easy drawing when ascending, and the hard work down. This plan also gives the advantage when carrying in harvest of running one wheel in the upper furrow, and the lower wheel on the land, which will bring the body of the cart to a level although crossing the hill at an angle of forty-five degrees. If the hill should be so steep that when the wheels are placed as above the cart does not come level, but hangs down hill, taking a plough and turning a few inches out of the bottom of the furrows will answer the end; we are thus enabled to reduce the incli-

nation both of ascent and descent as low as circumstances will permit; by this plan, and by my rest and slipper, I have been enabled to carry my corn without any difficulty from two fields that rise at an angle of twenty-five degrees, without using a trace-horse, which fields my predecessor never harvested without having a waggon or two upset, and I have never had a cart upset since I came to the farm five years ago. The fact is, that carts made wide and low are not nearly so liable to be upset as waggons, which are so high and narrow; indeed, if it were not for the weight of waggons they would be easily overturned.

Some men are afraid that their horses' backs would be broken by the loaders happening to load too much forward; but with a drag, for taking all the weight off the horse's back going down hill, they need not be afraid if their men use common precaution. If ever such a thing does happen as a load being so heavy on a horse's back as to be dangerous, taking the horse out, after the load is well tied, and letting it up once or twice on the tips, will make it light enough on the back; and if it is too light on the horse's back, letting down on the shafts will put that also to rights; and in going up hill, letting down the prop behind will prevent its rising, supposing they should load it all behind; but I have never experienced any difficulty in getting my corn well loaded; in fact, I have often put a lad to this work who never did it before, and in a few days he could accomplish it as well as any other on the steepest land I have got; but as I have always two loaders, I give 6*d*. a day more to the loader and pitcher who sends the best and most loads in the day, which stimulates them in improving; and I receive a benefit through the increase of work done by my horses, as well as the pleasure of seeing work going on like clockwork.

The next work that occurs on my farm is the drawing of lime, which we draw above 12 miles, each horse bringing 4½ quarters, or 23 cwt., the cart weighing about 7 cwt., making a total of 30 cwt. gross for each horse, the cart being about one-fourth of the load. With a waggon and four horses my neighbours bring 13½ quarters, weighing about 70 cwt., the waggon about 28 cwt., making a total of 98 cwt., or 24½ cwt. each horse, the waggon being about two-sevenths of the load, and their horses working harder than my three are worked with carts, although mine have more by 6 cwt. each to draw; in fact, I am certain from strict observation, that four horses are not able to draw more in a waggon than three horses can with good Scotch carts; because, in the case of four horses being yoked to a waggon, two a-breast (which is generally believed to be better than at length), when either horse draws more than his companion (which is often the case), he has to work hardest with the shoulder next his lazy companion,

because his drawing too much has a tendency to turn the waggon round towards his companion, to prevent which he must needs draw most with the shoulder next the lazy one, that the waggon may be kept going straight along the road. I have been told by some of those who are very fond of waggons, that the driver can prevent all that, which I will grant, but does he do it? The fact is, that good horses have license to work themselves to death, while an old knowing one has leave to act the rogue. But there is another evil out of the reach of the best driver; which is this; he cannot make all the horses take their steps alike long, consequently they do not keep pace with each other; hence the evil when the last horse starts right foot first, and the fore horse left foot first: each horse is drawing with contrary shoulders, consequently it almost amounts to only one horse in place of two, for want of unity; it is evident that when four horses proceed in a confused march, their strength is not applied so well as if they kept pace with each other in good order, which is an advance of discipline in the farming-stud which I am not sanguine enough to expect.

I am not of opinion that it would take more power to draw a waggon with three tons on it (provided that it was the same weight as the three carts) than it would take to draw three carts with a ton each; but, from the reasons stated above, I consider that there is a horse-power lost in the irregularity of the application of the four horses through bad driving, &c.

Now for the proof whether waggons or carts are the most economical: as it takes one man to two horses in the latter, and only a man to four in the former, it will be best to suppose six horses and three men with carts, which will bring home about 7 tons of lime, the carts weighing about 2 tons, making a total of 9 tons, or 30 cwt. per horse. The expense of six horses, at 3*s.* per day, is 18*s.*, and of three men, at 2*s.* per day, 6*s.*, or a total of 24*s.*, or 3*s.* 6*d.* per ton, with carts. With two waggons the same quantity can be brought (but seldom is), the waggons weighing nearly 3 tons, as observed before—eight horses, at 3*s.*, will be 24*s.*, and two men, at 2*s.*, will be 4*s.*; making a total of 28*s.*, or 4*s.* per ton, with waggons, being one-eighth in favour of carts, without counting the extra turnpikes for eight horses in place of six. There is another great disadvantage in waggons, which is, the getting them emptied, as well as the extra work in loading them, which I believe is quite equal to the extra man required for the six horses, and would leave the one-fourth gained in horse-labour clear.

In fact waggons never had any recommendation but one, and that was the advantage of dragging down hill, and not oppressing the horse in the descent, which difficulty has been quite overcome by the invention of a drag for carts, which can be applied

without stopping the horses, and takes all the weight off the horse's back completely, and drags slightly, or severely, according as the hill is very steep, or moderately so. One such drag I have invented myself.*

The next work that comes on my farm is the harvesting of corn; and as I have now fixed a plank, 11 inches wide by 2 inches thick (for the emptier to stand on), which rests upon the arches that keep the load off the wheels, by this means the man is raised above 5 feet from the ground, while pitching the bottom of the load, giving nearly all the advantage in height of waggons in the stackyard, and still retaining all the advantages of lowness in the field.

In proof of the pitching in stackyard and in field being alike, I always pay a halfpenny per hundred sheaves in field, the same loading, and the same repitching on stack in stackyard, and I have all my stacks raised 14 feet from foundation before I have the head or roof begun to be made; but I generally have a second stack begun, whenever the first is 12 feet high, and one man pitches the highest part of each load on the high stack, until the other load arrives, then he goes and pitches the remainder on the new stack; the other pitcher beginning to pitch the newly arrived load on the high stack. By this plan the horses are less

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* My drag is merely a rest with a slipper fixed to the foot, the same as those used on waggon wheels, only cast with a hole or socket to receive the rest in place of a groove to receive the wheel. The rest is made in the form of the letter T, with the ends of the cross inserted into a socket or thimble fixed to the shafts of the cart, the near or left side socket or thimble being fixed 6 inches from the axle, and the right or off side socket or thimble fixed 3 feet 6 inches from the axle, which causes the drag, when raised, to come up to the outside of the near shaft, where there is a hook to hang it to. The drag-chain is fixed to the centre of the front bar, between the shafts, which should just be long enough to allow the rest to come to the perpendicular. There is also a small chain or cord fixed to the slipper, which the driver, by pulling and raising the shafts at the same time, causes the rest to rise, which he then hangs upon the hook. When he wishes to apply it, he unhooks it, when it falls to the ground, when by raising the shafts the rest comes to the perpendicular, and receives all the weight that was on the horse's back, along with the increase caused by the rest's being so near the axle, so that it will be nearly double the weight borne by the horse. The chain attached to the slipper and fixed to the front bar between the shafts preventing the rest from getting beyond the perpendicular, the weight upon the slipper being increased in proportion to the steepness of the hill, the increase of weight causing an increase of friction upon the slipper, therefore increasing its stopping power. Also the weight of draft caused by the friction is brought to bear upon it through the medium of the chain attached to the front bar, which of course is also increased with the steepness of the hill descended.

N.B.—Gentlemen wishing to see these drags and carts with self-actioned backs, invented by me, may do so by visiting Mr. John Nethercot, Pells Farm, Greenford, Middlesex, and my farm at Naseby, Northamptonshire.

delayed than they would be by first finishing the stack and then beginning another, and it equalizes the work of pitching, and does away with the disadvantage of the lowness of carts altogether, retaining all the advantages of their lowness in the field; so that, with good management, I rather think that carts are better than waggons in the whole, as far as manual labour is concerned; and there is no doubt of carts being more economical than waggons as to horse labour. I have my sheaves all made from eight to nine inches in diameter, and I find by experience that men cannot get more wages pitching and loading where the sheaves are short than where they are long, although it is easier work, because there is more travelling between the shocks, consequently more time lost. I have found, on looking over my register of crops grown within the last five years, that I have reaped wheat straw from two and a a half to six feet long, and find that the following rule will generally give the number of sheaves that will be upon an acre, according to the length of straw, provided they be of a proper thickness:—At 6 feet long there will be about 1080 sheaves per acre, and taking 180 off for every foot the straw decreases in length, will give the number that will be produced per acre. As the greater quantity of corn in the short straw, in proportion to the number, will almost balance the decrease in weight of straw by shortness, 340 sheaves being a fair load for one horse, there will be about a decrease of a half load per acre for every decrease of one foot in the length of the straw. I have always, when at all possible, had my crops harvested by task; and I have paid the same, namely, a penny, for pitching and loading in field; but when the straw got less than three feet long I put three loaders and three pitchers in field, to keep two pitchers going in the stackyard, and giving them in the stackyard a halfpenny for from 120 to 150 sheaves; so that the stacking does not cost so much when the straw is short.

I pay the stackers the same as the pitchers in the stackyard, with an addition of one-eighth to the leading stacker and guide.

The expense of bringing home and stacking will be: for pitching and loading one penny; for pitching on stack one halfpenny; and stacking one penny; making a total of two-pence halfpenny per 100 sheaves: therefore the expense of carrying home and stacking will vary from 2*s.* 3*d.* to 9*d.* per acre for manual labour. The expense of horses and driving will increase according to the distance between field and stack, and the quickness of loading and unloading. The number of horses required can be found by the rule given at the beginning of this paper.

I find that three pitchers and three loaders will put up 340 sheaves in twelve minutes; and two pitchers will empty them on stack in the same time. I make my horses trot back with the

empty cart, if required; but by a horse travelling at the rate of four miles an hour, he will go a furlong and retrace his steps in four minutes; therefore the distance in furlongs should be multiplied by four, and divided by twelve, the number of minutes taken to load, so that four horses will do, until the distance is more than three furlongs, when an extra horse or faster travelling will be required. At three furlongs and under the expense of horse labour will be about a penny per 100 sheaves; and for every increase of three furlongs the horse labour will increase about a penny per 340 sheaves. Therefore, as 180 sheaves are the increase caused by a foot in length of straw, there will be an increase of one and four-fifth pence in the horse labour, and three and six-tenth pence in the manual labour, making a total of six and three-tenth pence, as the expense of carrying for every foot the crop is in length, with an addition of about a halfpenny for every three furlongs above three, in distance. I find that, by mowing wheat, the number of sheaves will be increased about $\frac{1}{6}$th, if well done; and oats increase about $\frac{1}{5}$th by mowing; therefore the expense in manual labour is increased. The number of sheaves on an acre of oats is about one-fourth more than wheat, when both are reaped. I may remark that I always have my crops reaped within from four to six inches of the ground, at which oats with straw six feet long will produce about 1350 sheaves per acre; but I do not pay so much for pitching, loading, and repitching, by one fourth, as I give a halfpenny for 125 sheaves; and I have found that a horse will take a fourth more in number of oat sheaves than wheat, except where the oats have been mown, and are a very large crop, when the sheaves become too bulky: but where they can conveniently be put on, the horse will draw them; therefore the carrying of oats is about the same as wheat. The decrease in number of sheaves per foot in length of straw is about 220 in oats. My men would rather carry wheat than oats at the same length of straw; but they like a middling crop of both best. When I am carrying a great distance, and have a hard road, I put on very large loads, and have a horse to trace them out of the field, because the time taken in travelling is so much more than is taken in loading or emptying, therefore increases the number of horses required too fast, as will be found by the rule.

The next work that takes place on my farm is the carting off roots, for which no sane man would think of using waggons; and the arguments applied to the carting out manure in two-horse carts are equally applicable to this, especially as one-horse carts, being lighter, do not consolidate the ground so deep as large heavy two or three-horse carts.

The next work is the marketing of corn, to which the same ar-

guments in favour of carts are applicable as in drawing lime, &c., namely, one-fourth saving of horse-labour, against which there is about the fourth of a man; but when the facility of loading and unloading is taken into consideration it will reduce the loss in manual labour to a trifle.

I think that there is no sort of farm-work for carts or waggons that I have not treated of, and will now therefore sum up the whole, that we may see the final results.

First, I take carting out of manure, which gives rather more than a fourth in favour of one-horse carts over two-horse carts; waggons being out of the question altogether for that sort of work.

Secondly, In the carrying of hay there is a saving of horse labour to the amount of a fourth, as well as some advantage in the manual labour, through their lowness in field, notwithstanding the very small disadvantage of height in the rick-yard.

Thirdly, In the drawing of lime, stones, slates, tiles, or manure great distances, there is a saving of at least a fourth.

Fourthly, In harvest work there is a saving in one-horse carts over waggons with only two horses in them; and allowing that they would be able to draw 2 tons in them besides the waggon (which I believe is not possible); but it matters not, for even if they could, carts are then the most economical by at least one-seventh, both in horse and in manual labour at harvest work, which is the most important of all work.

Fifthly, In carting of roots there is the same saving over two-horse carts, as in the drawing on of manure, namely, one fourth.

Sixthly, In the marketing of corn, the one-horse carts have the same advantages over waggons as in carting lime, &c., namely, one-fourth in horse labour, but a drawback of one-eighth in the manual labour, making a clear saving of an eighth.

It would appear, from every rule and observation that I have made these five years, that there is a general saving of one-fourth in horse labour at all sorts of work; but in going distances from home there is a drawback of about a third in the manual labour; but when there are four horses and carts going out, a strong boy would do, thereby reducing that expense. In fact, all the increase of men will not amount to more than will pay the interest of the money sunk in waggons; and as every man must have a certain number of carts, whether he keep waggons or not, therefore it is an important consideration, whether a man buys four or five waggons, besides dung-carts, or whether he should buy six first-rate new harvest carts, made of good larch or red pine, realizing a saving of about 70 per cent. to buy some good implements with, to assist in growing some long straw, that will lie on the carts.

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XV.—*A Form of Memorandum on Tenant-right to be added to existing Agreements or Leases.* By Barugh Almack.

The adoption of protective covenants for the improvements of tenants, and the consequent establishment of a custom under which all questions between landlord and tenant should be settled by arbitration, would not only encourage tenants in expenditure upon their farms by giving them a just security for their outlay, but would incidentally afford a means of simplifying and improving the clauses in farm-agreements, as the tenant's claim on account of his improvements would be liable towards the owner for the dilapidations which the tenant might have caused in other parts of the farm; and as I cannot help thinking that many landlords would be disposed to afford their tenants some positive and substantial security, if they could only see a ready and unobjectionable mode of doing so, I will venture to suggest the following one, in case they should not discover a better. The chief plan of it was drawn up about a year ago, and annexed to the end of a form of farm-agreement, as here exhibited; but some changes were made in it by Mr. Pusey in adopting this memorandum for his own estate, and those changes have been introduced here.

Although in several cases the number of years is inserted, it is obvious that the proportions (or number of years for allowance) should be regulated partly by the nature of the materials, and partly by the value of the workmanship. In all improvements, too, their value to the owner must be greatly affected by the probability of their being more or less permanent, and his liability in respect to them should be calculated accordingly.

AND the said   and
hereby mutually agree that if any dispute shall arise between the said
, their
executors and administrators, upon the said
quitting the said farm, or upon the state of cultivation or condition thereof—such dispute shall be settled by two referees, one named by each party, or their umpire—and in case one party refuse to nominate a referee within ten days after notice has been given in writing by the other party, the referee of the other party alone may make a final decision. If two referees are appointed, they are to nominate an umpire before proceeding to business, and the decision of such referees or umpire, as the case may be, shall be final.

WITNESS the hands of the parties.   A. B.
C. D.

Memorandum.

In order to encourage the tenant to cultivate the farm in the highest possible manner, the said   hereby engages on behalf of himself and his representatives, owners of the farm* let to

* These words are thus limited to the future *owners* of the farm, in order to prevent the charge upon the land from applying to the personalty of a deceased landlord, which may have been devised by him to parties other

the said *on condition* of the foregoing covenants having been fulfilled and kept by the said his executors or administrators, that in case of the death or incapacity of the said or of his having received notice to quit the said farm, and quitted it agreeably to and in consequence of that notice (*or in case of the expiration of the term of a lease for years*), the said or the incoming tenant will allow to the said or his executors, administrators, or assigns for such improvements made on the said farm subsequent to the date of this memorandum, and within the stated periods, before quitting, as are contained in the following list, and are marked and enumerated with the figures, that is to say, so much of the amount of such expense as shall be in the given proportion in each case to such a number of years as the said his executors, administrators, and assigns shall fall short in the occupancy of the said farm after incurring such expense, *it being expressly stipulated that the tenant is to give an account each year* of such outlay as he proposes to make in matters of *durable* improvement, in order to obtain the owner's sanction to the proposed expense, *such sanction being necessary in order to claim or be entitled to any allowance* from him, and shall also render an account of such disbursements within each year: such account to be examined and signed by the landlord or his accredited agent, and to serve as a voucher for the sums so to be recovered by the said tenant; and that non-payment of rent (if the same shall have been demanded and have afterwards remained unpaid for the space of six months) or non-fulfilment of covenants shall *forfeit* any claim or right to such allowances for improvements.

The proportion of the proposed conditional allowances to be regulated as follows :—

DURABLE IMPROVEMENTS.

1. If the tenant drains the land at his own expense, with the consent and subject to the inspection of the landlord or his agent, an allowance to be made for the materials and workmanship for [*eight to fourteen years*, *as the case may be*] years, so that the allowance shall yearly diminish in equal proportions, and be cancelled by years' enjoyment of the improvement.
2. For lime used on the land, with like sanction, the allowance to extend in like manner for *four* years.
3. For marl or chalk used on the land, with like sanction, the allowance to extend in like manner for *eight* years.
4. For clay used on the land, with like sanction, the allowance to extend in like manner for [*six to eight*] years.
5. For buildings erected on the land, with like sanction, the allowance to extend in like manner for [*twenty*] years.

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stahe successors to his real estate; but at the same time it must be fairly powbat a doubt may arise how far the owner of a settled estate is em- cially in the present state of the law, to bind the heir of his land, espe- colnshironey laid out in building, though I am not aware that in Lin- permanenere the *custom of the country* sanctions such charges for other rrovements, any difficulty has ever arisen as to their validity.

TEMPORARY IMPROVEMENTS.

6. For bones used on the land, the allowance to extend in like manner as to diminishing for *three* years.
7. For bought dung and night-soil used on the land, the allowance to extend in like manner as to diminishing for years.

8, 9, 10, 11, 12, 13. Other manures, as the case may be.

14. For linseed cake used for feeding cattle or sheep on the land or premises, the allowance to be one-third of the cost for the first year, and one-sixth for the second year.

A. B.

In considering this form, it is necessary to bear in mind that it was drawn up at a period when there seemed to be less probability of low prices for agricultural produce than now: that it was drawn up with the feeling that, as a land-agent, I was bound to protect the interest of the landowner, and therefore, if possible, to do the tenant justice, without risking any loss to the owner. Thus it may be considered less favourable to the tenant than *some* of them, under present circumstances, would think necessary. If landowners can induce tenants to lay out their capital in judicious improvements, under this form of covenants, they may be considered as fortunate in having tenants so liberal. As this may be seen (and I hope will) by landowners, land-agents, and tenants, I shall be greatly obliged if any of them will point out a better means of accomplishing the object in view, namely, benefiting all parties without injuring any of them, by such arrangement.

The form appears to possess the following advantages:—

First,—It may be attached to almost any agreement as at present existing; although it is very important for all parties, and for landowners as much as any, to see whether old Agreements cannot be altered so as to benefit tenants without any, even temporary, loss to owners.

Secondly,—It may be made the most effectual means of binding the tenant to the due observance of his present agreement.

Thirdly,—It will secure the owner against any *probable* negligence on the part of the tenant, as regards expenditure in improvements, inasmuch as the tenant *may have* to pay for the whole if he should live and the owner not choose to take them off his hands.

The owner need not, except in case of death or incapacity, take them off the tenant. He would therefore, as a general rul be certain of a new tenant, who would take upon himself he specified responsibilities before he parted with the old one. I ay, cases of durable improvement, which involve the heaviest efore the responsibility on the owner would be voluntary, and o it. he could not be injured without becoming himself a pwner has

The responsibility really amounts to nothing if of an agent taken care to place his estates under the manager

capable of judging what would be improvements; because he would only have to pay for part of what he had got; and, in such case, if there were no improvements, there could be none to pay for.

23, Alexander Square, Brompton, near London.

XVI.—*On the Distinction between the Dormant and Active Ingredients of the Soil.* By Dr. Daubeny.

In the Bakerian Lecture for 1845,* I took occasion, whilst treating of the Rotation of Crops, to insist upon the distinction between what may be termed the *dormant* and the *active* ingredients of a soil with reference to the plants that grow in it.

When we consider, I remarked, the nature of a soil in an agricultural point of view, or in reference to its suitableness for the growth of various kinds of vegetables, two questions naturally come before us; namely, what amount of ingredients capable of being assimilated in the course of time by the crops does it contain; and secondly, what is the amount of those which are present in a condition to be actually available for their purposes, at the precise moment when the examination is undertaken.

Both the above points are obviously quite distinct from that relating to the total amount of ingredients which exist in it, and hence some might be disposed to add to the labour of the two preceding investigations, that of ascertaining the whole of its constituents, whether in a state to be affected by the ordinary agents of decomposition, or not.

The latter question, however, seems to me to possess, with reference to the agriculturist, only a speculative interest, and when introduced into a report intended for his use, may be more liable to mislead than to instruct, unless due caution be taken to point out to him, how much of each ingredient is to be regarded as inert, and how much of it as applicable to the future or present uses of the plant.

Let us take the case of a natural soil, composed of certain kinds of disintegrated lava, or even of granite, in which it is evident, that an actual analysis, conducted by means of fusion with barytes, or lead, or by any of those other processes which chemists employ for decomposing compounds of a refractory nature, would detect the presence of a large per centage of alkali, not improbably of a certain amount of phosphate of lime, and in short of all those ingredients which plants require for their support in sufficient abundance. Nevertheless, land of this description, in conse-

* Philosophical Transactions, Part ii., for 1845.

quence of the close union of the elementary matters of which it consists, and the compactness of its mechanical texture, might be as barren, and as incapable of imparting food to plants, as an artificial soil composed of pounded glass is known to be, notwithstanding the large proportion of alkali contained in it.

Thus I have myself observed,* that the soil which covers the serpentine rock of Cornwall, although the latter is principally made up of a mineral consisting of—

Silica	43·07
Magnesia	40·37
Alumina	0·25
Lime	0·50
Oxide of iron	1·17
Water	12·45—HISINGER.

contains, nevertheless, so minute a proportion of magnesia, that in an analysis of a small sample its presence had been altogether overlooked by me, in so great a degree may the mechanical condition of the components, and the state of combination subsisting between them, preserve a rock from the decomposing action of the elements which tend to set loose its treasures.

Now it seems obvious, that whatever cannot be extracted from a soil by digestion in muriatic acid during four or five successive hours, must be in such a state of combination as will render it wholly incapable of imparting anything to a plant, for such a period of time at least as can enter into the calculations of the agriculturist; and moreover, that all which muriatic acid extracts, but which water impregnated with carbonic acid fails in dissolving, ought to be regarded as at present contributing nothing, although it may ultimately become available for its purposes.

I have therefore thought proper to distinguish between the immediately available resources of the soil, and those ultimately applicable to the uses of the plant, designating the former as its *dormant*, and the latter as its *active* ingredients.

The portion dissolved after digestion in muriatic acid will contain both the *dormant* and the *active*; that taken up by water impregnated with carbonic acid will consist merely of the latter; the difference in amount between the two will therefore indicate the *dormant* portion of its contents.

The *dormant* and *active* portions may both be comprehended under the designation of its *available* constituents, whilst those which, from their state of combination in the mass, can never be expected to contribute to the growth of plants, may be denominated the *passive* ones.

Every soil which is capable of yielding an abundant crop of

* Lecture on the Application of Science to Agriculture, from the Journal of the Royal Agricultural Society of England, vol. iii. part i.

any kind of plant after fallowing, must be assumed to possess in itself an adequate supply of all the ingredients necessary for its support in an *available* condition; but it is plain that these could not have existed in an *active* one, or such an interval of rest would not have been required for rendering them efficient.

Accordingly it is quite possible, that after ten years' cropping, the soil of my experimental garden might still retain plenty of alkaline salts and phosphates, although what was ready to be applied to the uses of the plant had for the most part been absorbed by the crops previously obtained.

With a view then to this branch of the inquiry, I first ascertained the nature and amount of the ingredients separable from a given weight of the soil by means of muriatic acid, and 2ndly, those obtained from the same by a definite quantity of water impregnated with carbonic acid gas. By a careful analysis it was ascertained that the soil of the Botanic Garden at Oxford contained, within an area of 100 square feet, and a depth of 3 feet from the surface, 3·5 lb. of phosphoric acid, 6·9 lb. of potass, and 2·9 lb. of soda, all in a state to be separated from the general mass by muriatic acid.

That the above, however, were for the most part in a *dormant* condition, appeared from the much smaller amount of the same which could be extracted by water containing carbonic acid, for it was found that of alkaline sulphates* not 11 lb. could be procured by these means, whereas

6·9 lb. of potass would have formed	12·7
2·9 lb. of soda . . .	6·5
Together .	19·2 lb.
Extracted by carbonic acid water .	11·0 ,,
Difference .	8·2 ,,

and that of phosphate of lime only 7134 gr., or less than 14 ounces were obtainable; whereas 3·5 lb. of phosphoric acid, equal to near 7·0 lb. of phosphate of lime, had been taken up by muriatic acid from the same.

By operating in a similar manner upon soils of the same quality as the above, which had been exhausted by several years' previous cropping, it appeared, that whilst the amount of the ingredients alluded to as *dormant* in the soil did not much vary in the two cases, that of the *active* ones was beyond all comparison greater in the sample of unexhausted soil.

This will appear from the following table :—

* The alkalies were estimated as sulphates, as it was found convenient to unite them with sulphuric acid, in which state they admitted of being heated and weighed without incurring loss.

TABLE of the QUANTITY of ALKALINE SULPHATES and EARTHY PHOSPHATES extracted by means of Water impregnated with Carbonic Acid from the Soils enumerated below.

Soil examined and treated with water.	Quantity of water added.	Quantity of alkaline sulphate obtained.	Nature of the alkali.	Quantity of alkaline sulphate per quart of water.	Quantity of alkaline sulphate in 1 lb. of soil.	Quantity of alkaline sulphate in 100 square feet (24,600 lbs.) of the soil.	Quantity of earthy phosphate taken up.	Quantity of earthy phosphate per quart of water.	Quantity of earthy sulphate per lb. of soil.	Quantity of earthy phosphate in 100 square feet of soil. (24,600 lbs.)
	qts.	gr.		gr.	gr.	gr.	gr.	gr.	gr.	gr.
From the contiguous garden, first time	2	5·2	Potass.	2·6	..	..	0·7	0·35		
From the contiguous garden, second time	2	7·8	Potass.	3·9	..	..	0·7	0·35		
From the contiguous garden, third time	1	3·4	Potass.	1·7	..	..	0·05	0·05	0·29	7134
From the contiguous garden, fourth time	1	2·6	Potass.	1·3	3·4	83,640				
From the permanent bed of Barley	2	0·6	Soda.	0·30	0·12	2,950	0·30	0·15	0·06	1470
From the permanent bed of Potatoes	2	0·7	Soda.	0·35	0·07	1,700	0·25	0·125	0·05	1200
From the permanent bed of Hemp	2	0·6	Soda.	0·30	0·12	2,950	Scarcely appreciable.			1470
From the permanent bed of Flax	2	0·5	Soda.	0·25	0·10	2,450	Scarcely appreciable.			2940
From the permanent bed of Turnips	2	0·6	Soda chiefly.	0·30	0·12	2,950	0·30	0·15	0·06	3180
From the permanent bed of Beans	2	0·5	Soda.	0·25	0·10	2,450	0·60	0·30	0·12	4900
From the shifting bed of Barley	2	0·7	Soda chiefly.	0·37	0·07	1,700	0·065	0·0325	0·013	3420
From the shifting bed of Potatoes	2	1·0	Soda chiefly.	0·50	0·20	4,900	0·100	0·050	0·020	4900
From the shifting bed of Hemp	2	1·0	Soda chiefly.	0·50	0·20	4,900	Scarcely appreciable.			
From the shifting bed of Flax	2	0·3	Soda chiefly.	0·15	0·06	1,470	0·7	0·35	0·14	3420
From the shifting bed of Turnips	2	3·6	Potass.	1·8	0·72	17,700	0·9	0·45	0·18	4410
From the shifting bed of Beans	2	1·0	Soda.	0·50	0·20	4,900	0·30	0·15	0·06	1470

From these facts, and from others stated in the course of my memoir, I have conceived myself warranted in deducing the following conclusions:—

1st. That it is quite consistent with the general tenor of the preceding facts and observations, to maintain with Boussingault, that the falling off of a crop is dependent as well upon a deficiency of organic matter proper to promote the nutrition of the plants, as upon a failure of its inorganic principles; not indeed that the organic matter enters, as such, into the constitution of the vegetable, but that by its decomposition it furnishes it with a more abundant supply of carbonic acid and ammonia, which supply accelerates the development of its parts, and thus at once enables it to extract more inorganic matter from the soil, and enables the soil to supply it more copiously with the principles it required for its nutrition.

Hence, perhaps, in part, the advantage of intercalating the Leguminosæ and other fallow crops, which generate a larger amount of organic matter than the Cerealia, and which thus serve to enrich the soil by what they leave behind them.

2ndly. That it by no means follows, because a soil is benefited by manuring, even though that manure may, as in the case of bones, guano, &c., derive its efficacy from the phosphates it supplies, that it is therefore destitute of the ingredient in question, since it may happen that it possesses abundance of it in a *dormant*, though not in an immediately *available*, condition.

In these cases, in which the agriculturist has been assured by the results of actual analysis, that there is no real dearth of the principles essential to his crops in the soil under cultivation, but where he has ascertained, either by the chemical mode pointed out, or by an experience of the good effects brought about by manures, that the substances in question are not in a state to become immediately applicable to the purposes of vegetation, three courses appear to be open to him:—

1st. To apply a sufficient quantity of the same materials in a state in which they can be absorbed by the plants without delay; 2ndly, to allow the ground to remain fallow, by which expedient time is given for a further decomposition of its materials, and for a renewed extrication of its useful ingredients, to take place; 3rdly, to produce, by the various methods in daily use, such a stirring and pulverization of the ground, as may admit of a more thorough admission of air and moisture, and consequently accelerate the process of disintegration in a greater degree than would take place under natural circumstances.

Examples will occur to every one of the successful adoption of each of these three practices: of the first, in the ordinary process of manuring, and especially in the beneficial consequences result-

ing from the use of bones in the exhausted pastures of Cheshire and other similar localities; of the second, in the system so general in the early stages of agriculture, that of allowing land to remain at rest for a certain period with a view of restoring to it its exhausted powers,—a method which would be absurd, if the alkalies, phosphates, and other of the more scanty ingredients were absolutely wanting, but which would be likely to prove efficient, if they were only locked up within the recesses of the soil, and required time to call them into activity; of the third, in the practice resorted to by Jethro Tull, who boasted that he could realize an abundant crop year after year without manure, provided the ground were sufficiently stirred and broken up,—a statement which seems confirmed, by some of the results of spade husbandry, and in a certain degree by those detailed in this paper, with respect to the permanent crops which are herein mentioned as having been made the subjects of experiment.

The choice between the above three methods will of course be determined in each instance by a balance of economy; and although in general this latter consideration will incline the farmer to prefer the ordinary method of manuring, either to the sacrifice of a year's produce, as in the second method, or to the expenditure of labour required to put into practice the third, still there may be cases where it might better answer his purpose to resort to one or other of them, as being more advantageous in itself, or else more suitable to the circumstances of his case.

At any rate it may be important for him to be assured, that at the very time he is ransacking the most distant quarters of the globe for certain of the mineral ingredients required for his crops, he has lying beneath his feet in many instances an almost inexhaustible supply of the same.

For there seems no reason to doubt, that the whole mass of rock, which constitutes the subsoil in the secondary and tertiary districts of this country, is nearly as rich in phosphates and in alkalies as the vegetable mould derived from its decomposition; and although the soil, in which the experiments in my garden were conducted, possessed a depth perhaps three times as great as the average of those in which farm produce is generally raised, yet, on the other hand, the amount of phosphates and of alkaline ingredients reported to be present in the latter appears in many instances greater than that determined in the case before us.

Thus Dr. Ure* gives an analysis of a soil in the parish of Hornchurch, Essex, which contained four grains of phosphate of lime in 1000 grains; whereas, of ours, the same quantity yielded little more than one-fourth of a grain; and if the former be re-

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* Journal of the Royal Agricultural Society.

garded as an exceptional case, I might have referred to Sprengel, who states that the per-centage of phosphoric acid in the soils he analysed varied from 0·024 to 0·367; and in the subsoils from about 0·007 to 0·2.

I detected many years ago phosphate of lime in several secondary limestones chiefly taken from the oolitic formation, and Mr. Schweitzer of Brighton has determined the proportion of that ingredient in the chalk near Brighton, to be not less than one grain in the 1000. We need not therefore resort to South America for bones, if means could be found for extracting this ingredient economically from the rocks of our own country.

3rdly. These facts place in rather a new light, although one, it is conceived, not less striking than before, the importance of taking care of the various excrementitious matters at our disposal, whether proceeding from animal or from vegetable sources.

Such substances indeed contain the products which nature has, with so large a consumption of time, and by such a number of complicated operations, elaborated from the raw material contained in the soil, and has at length brought into the condition, in which they are most soluble, and therefore best fitted to be assimilated by the organs of plants.

To waste them is therefore to undo what has been expressly prepared for our use by a beautiful system of contrivances, and to place ourselves under the necessity of performing, by an expenditure of our own labour and capital, those very processes which nature had already accomplished for us, without cost, by the aid of those animate or inanimate agents which she has at her disposal.

4thly. The analyses above reported may suggest caution as to the inferences which some might be disposed to deduce from certain researches lately announced, with respect to the power which a plant possesses of substituting one alkali, or one earth, for another in the processes of vegetation.

This substitution indeed, however brought about, is a fact which hardly admits of being questioned, supported as it is by the testimony of men so eminent as Saussure and as Liebig; and indeed many of the analyses detailed by me in the Philosophical Transactions might be appealed to in corroboration of its truth.

Thus we find, that whilst the amount of bases agreed pretty nearly in the three crops of the same plant which had been analysed, the proportions between them often varied considerably. This is particularly seen in the case of the lime and magnesia, the deficiency in one of these earths being often made up by an excess in the other.

In like manner a deficiency of potass is found to be compen-

sated by an increased amount of soda, and the same remark seems to apply to the acids.

Still we have not as yet sufficient data for determining to what extent this exchange of the usual ingredient for another can take place; whether indeed the same organ, or the same proximate principle belonging to the plant, may admit at all of this change in its constitution taking place; or if it can, in what degree the presence of this new principle may affect its healthy development.

By turning to the Table which states the relative quantities of alkaline ingredients extracted by water impregnated with carbonic acid from the different soils, it will be seen that in most of these the amount of soda predominated over that of potass, and yet the latter alkali was principally found in their ashes; an indication at least of some superior adaptation of potass to soda with reference to the organization of plants.*

Again, it is remarkable, that whilst in several of the soils soda appeared to exist in the form of a carbonate (since the quantity of chlorine was so small that only a minute trace of it was discoverable in them), in many of the ashes of the plants only as much soda was detected as would contain sodium equivalent to the chlorine present.

Hence it would seem to follow, that common salt, when it acts beneficially upon land, does not assist the crop by virtue of the alkali it imparts to it, but operates in some other as yet unexplained way; and that it is still questionable, at least in the case of terrestrial species, whether plants have the power of decomposing chloride of sodium, and of separating its chlorine.

Lastly, the analyses contained in this paper may be of use at the present moment, by contributing to show how much still remains to be done, before we can flatter ourselves at having attained any sure knowledge of the normal constitution of plants, or of the range of variation of which under natural circumstances it is susceptible. At a time when certain enlightened members of the Royal Agricultural Society have prevailed upon that great Body to devote a portion of their funds to the prosecution of the chemical analysis of the ashes of vegetables, whatever tends to render more palpable the importance of such an investigation may be of service, in aiding their meritorious efforts to give a more scientific direction to the inquiries which such Associations are intended to promote, and in vindicating the utility of the course which they have in this instance adopted.

* This is also shown very strikingly in a paper on the analysis of Fuci read to the British Association at Cambridge, by Mr. Schweitzer, in June, 1845.

Now the facts and observations detailed in the present paper contribute in two respects towards this object, viz., 1st., by showing that the composition of the most commonly cultivated plants is still open to much uncertainty; and 2ndly, by pointing out in what way an exact knowledge of their inorganic ingredients might aid us towards the solution of many important practical questions.

I hope it will not be attributed to any blindness on my part to the deficiencies and imperfections which exist in this paper, if I remark, that an investigation of a similar kind to the one herein detailed, if carried out on a more adequate scale, undertaken on ground more carefully selected, conducted with a more vigilant attention to all the minute circumstances which might influence the result, and accompanied by a regular series of analyses, both of the soil and of the crops, during the whole period of their continuance, would be of essential service in clearing up many points in agricultural science which yet remain questionable.

My memoir may serve also as a kind of illustration of that method of scientific book-keeping, which I proposed some time ago, at once as an useful exercise for the agricultural student, and as a means of introducing greater precision into the conduct of our experiments on this subject, and which I am therefore happy in having this opportunity of rendering more generally known and understood.

XVII.—*On Burning Clay for Manure.* By Walter Long.

To Mr. Pusey.

Dear Sir,—As you have requested me to write you an account of my mode of preparing a useful manure from burnt soil, and the method of burning, I shall be highly gratified if this communication of a very simple process should be of the smallest use to any agriculturist.

Our soil is a thin, dry, flinty loam upon chalk; and we suffer, unless we have abundance of rain in spring and summer: everything, therefore, is beneficial to our land that has the property of attracting atmospheric moisture, carbonic acid gas, &c. &c. With this object, the first point is to obtain ashes; those that are burnt in the fields from weeds and grass round the headlands, or from the grubbing of hedgerows, being full of vegetable matter, are the best and cheapest. These, however, can only be burnt in summer; and sooner or later, in farms that are kept clean, the materials are no longer to be found. Yet an inexhaustible supply may be obtained, and employment afforded throughout the winter, by

burning clay and strong earth in kilns protected from rain; the only difficulty having been, that many persons, and myself at first, produced a hard substance, *more resembling brickbats than powder*. This difficulty I obviated by (previous to burning) well saturating the soil with water, working it, and treading it to the consistency of mortar; for water will separate any particles, however adhesive: and then the fire expelling the water and the carbonic acid gas, leaves the particles previously separated, when burnt, in a state of very fine powder; and if any should not at first be quite separated, it slacks immediately on the application of liquid. Having saturated the soil thus with water, as much as a spade will hold is rolled up to the size of a large cannon-ball, and is handed to a man in the kiln, who places it on the bars or the coping of the brick arches over the furnace. He places each ball as he receives it side by side for two or three tiers, one above the other, and then lights the bavins in the furnace. In a short time the balls, wet as they are, become set or firm, and will not run into one another from the accumulated weight, as they would do if thrown in together in a rude wet mass. These tiers of balls are then covered with a layer of small roots or wood (which become charcoal), and then over this wood the moist earth is laid on, in spits, as loosely as possible, till the kiln is nearly full, and finally topped up with turf, or rape-roots, or any vegetable rubbish.

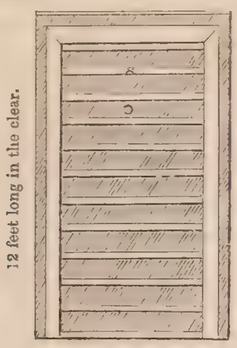
If the first tiers of balls be laid on over night, and the fire be kindled about seven next morning, all work of continuous burning may be so forwarded as to enable the men to block up the mouth of the furnace with roots or stools by five o'clock P.M., leave it to burn, and go home; and the next morning the whole will be found burnt out. In this way, there being three kilns, and one lighted every morning, one will be cooling, one will be unloaded and charged again with the balls, and one will be burning out, and so on in rotation. And by burning off two kilns any one day at the close of the week, and leaving them to cool, seven kilns may be burnt in each week, each containing about 160 bushels, and thus 1000 *net* bushels may be obtained weekly. When the ashes are taken out of the kiln they are sifted very fine, and made free from stones, chalk, &c., and wheeled to a covered shed, 50 feet long, and there laid out in beds, or pools, embanked by themselves all round, about two feet deep: a portable cask and pump annexed then continually brings from *various* tanks the overflowings of the farm-yards, the liquor from the stables, cow-sheds, piggeries, the house, and the laundry, and discharges it into these beds of fine ashes, which, when they have absorbed the liquor, are covered with a coat of gypsum.

They are then repeatedly turned, and repeatedly flooded, until

they have thoroughly imbibed the moisture, and remain fully charged with valuable matter. It is then packed away in another close shed, or store, and then trodden down by men, as hard and close as you may fancy guano to lie in its rocky bed; and so it remains, piled up to the upper tie-beams of the shed, and covered over with boards and hurdles, until dug out with a pick-axe for use. We thus have always a large store of manure, ready to drill for turnips, swedes, and roots of any kind, and a most excellent top-dressing for grasses and meadows; and in the kitchen-garden and flower-gardens it has been found a perfect substitute for farm-yard manure, and less productive of weeds. In its process it heats a good deal, and sends out crusts of saltpetre.

A rough larch shed roofed with beech boarding protects each shed and the workmen from wet.

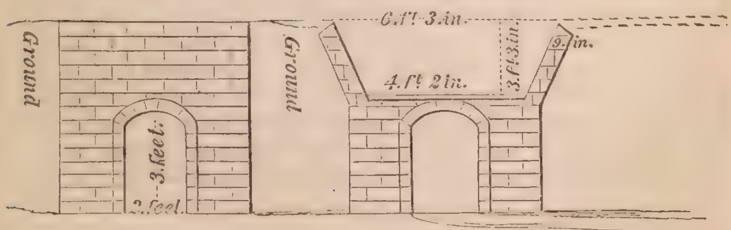
Ground plan of arches and bars bottom of the ashes.



4 ft. 2 in. wide at bottom, and 6 ft. 3 in. wide at the top.

The kilns are built in a dell, so that there is a road on the level of the top of the kilns to load and unload them.

No. 1. Front view as seen. No. 2. Section, if front were removed. Road above to unload.



6 feet. Road below to heat the furnace and carry away wood-ashes.

Should any stronger stimulant be required for drilling for swedes, &c., an addition of superphosphate, or guano, soot, pre-

pared night-soil, or, at any rate, powdered charcoal, is easily and readily made to this compost, thus (for the drill) counteracting any excess of moisture.

With a supply of soil or clay from any rough unproductive spot, with bush-faggots or firs, bavins and roots, or old timber stools, and by collecting in tanks all the animal liquor that would otherwise be lost, and then making the ashes the depository or vehicle of valuable liquor, it is not difficult for any one to command annually an immense quantity of good manure.

If the soil can be obtained near to the kilns, six men could carry on the whole work, and the whole value of the fuel consumed would be about two guineas weekly. Of course the total expense would be greater if the soil is to be carted to the kilns. I have given in the preceding page the measurement and plans of the kilns.

Faithfully yours,
WALTER LONG.

Preshaw House, Bishops-Waltham, Hants,
June 10, 1846.

I used this manure alone in 1843 and 1844 for Scotch yellow turnips, and after for rape—both crops were very good. I used it alone for rye-grass and clover, and for meadows, and invariably there was a great difference from where there was none; and again, it was always better where a greater quantity was used, or where heaps had been placed to be spread. The men employed, and the neighbours, used to point out the spots to me, and the natural growth of white clover and trefoil.

I have found it highly beneficial for oats, the saturated ashes sown thickly after the presser, producing a good crop in the places in which it was applied alone.

In my last year's crop of swedes I combined with the saturated ashes 3 bushels of bones and sulph. acid, and drilled them on land that was dunged; but the crop was 24 tons per acre on very poor land!

We all know the value of ashes as a vehicle to mix with better things: the only merit (if any, in my process) I consider to be the being able to burn it in kilns to powder instead of brickbats, and in the winter under cover, and finding useful employment for surplus labourers in bad weather, &c.; and also the suffering nothing to be wasted about a place in the way of liquid, by being provided with a constant receptacle in the ashes, and the combination becoming a sulphate of ammonia, and ever (when plenty in store) good at need, and for any purpose, either by itself or in combination with guano, soot, charcoal, &c.

XVIII.—*On Draining.* By Josiah Parkes, Esq., Consulting Engineer to the Royal Agricultural Society.

[Read before the Society at Newcastle-upon-Tyne.]

My Lord Portman and Gentlemen,

In fulfilment of the wish of the Council of the Society, and in anticipation that I, in common with its members, shall benefit by the remarks and larger knowledge of others, I have undertaken to appear before the present assemblage of agriculturists with the view of illustrating some of the principles and rules of practice in the art of land-draining. By so doing I do not think that I, or others who may follow me, shall be open to the charge of presumption, inasmuch as we may doubt if there lives the man, having acquaintance with the climate, soil, and agriculture of Britain, who would have the hardihood to dispute the assertion that drainage is beneficial, or the fact that vast districts in our island still require to be relieved from an injurious amount of water stagnant in its soil and stagnating too near its surface. I apprehend, therefore, that I may commence this paper by assuming—by taking for granted—unphilosophical and inadmissible as such a procedure would be in a doubtful case—that land-drainage is an art and a practice of acknowledged value and necessity; and that we are met here not to dispute about the propriety of draining wet lands, but simply to discuss the means of rendering the art of drainage efficient and economical, and to impart to each other our respective knowledge as to the modes of arriving at those desirable ends. I further apprehend that it should be our course to state, with precision, such practice as we may have severally pursued, its effects, and the causes to which the good or ill-success of the particular practice may, in our opinion, be ascribed. I imagine that we shall, in this way, best fulfil the object of the Council in inviting this discussion, for I subscribe heartily to the doctrine enforced in the Report of our Council to the general meeting in May last, viz., that "a clear knowledge of cause and effect, under given circumstances, and a detail of the particular cases to which such knowledge is applicable is, in their opinion, the only safe science to be recommended to their members." There is nothing contained in this declaration of the Council to discourage experiment, as has been feared and suggested to me by some of its members—from which circumstance partly I refer to it—since "safe science," if the term has a meaning, is simply expressive of that determinate state of knowledge which is founded on facts; and we cannot obtain facts but through experiment, observation, and experience. Let me mention a definition of science as propounded by that illustrious traveller and philosopher, Alex-

ander Von Humboldt, in his recently published work, 'Cosmos,'* p. 71. He observes, "Science begins at the point where mind dominates matter, where the attempt is made to subject the mass of experience to the scrutiny of reason; science is mind brought into connexion with nature." There is no difference in the sense of the two definitions, and the recommendation of the Council will put the members at their ease who have information to add to the common stock, and will, I trust, absolve them and myself from all charge of egotism, or desire of display, in speaking of our individual performances or opinions.

Experience has proved that a soil surcharged with water cannot perfect crops—that excess of water is an impediment to the due mechanical division of the active soil—that it diminishes the fertilising power of every species of manure—that it lowers the temperature of the mass of the bed—that it precludes the free entrance and change of atmospheric air—that it prevents the free descent of rain through the soil, and its timely evacuation. The existence of water in excess is far from being confined to those absorbent and tenacious descriptions of soil which have obtained the name of clays. My own observation of the soils of Britain leads me to the perception and belief, that fully as large an area of its extent, consisting of loams, and of earths still more siliceous, need drainage quite as much as the stiff and compact clays. Water is permanently maintained too near the surface of many soils, whose natural texture for a few feet deep would allow to it a free passage downwards, were it not for the existence of a clay or of some other impassable medium, at depths more or less great, which uphold water. The evils referable to the excess of water in soils are rendered peculiarly apparent, by comparing such water-logged land with those free, deep, naturally dry and warm soils, as they are called, which are so coveted by farmers; of which every one wants a slice, but which are so rarely to be met with, in comparison with the over-wet or too dry portions, of the superficies of our island. The object of drainage is to assimilate the naturally wet to the naturally moist soil, in so far as that can be accomplished by so simple an operation, and its effect upon the texture and physical condition of wet land will be the greater or less according to the knowledge and skill employed in performing the operation. In a former paper on this subject, entitled 'On the influence of water on the temperature of soils' (Journal, vol. v. p. 119), I endeavoured to bring together and lay before the Society a succinct history of the properties of water in its several states as a fluid, a solid, and a vapour or steam, and to show its effects upon soil; together

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* 'Cosmos; a General Survey of the Physical Phenomenon of the Universe.' Bailliere, 219, Regent-street, London.

with the action of other natural forces inherent in soil, or dependent on meteorological phenomena. I need not again refer in detail to the points discussed in that essay, nor further than to express the conviction, that without a pretty clear knowledge of the nature of those bodies, forces, and phenomena—without, in fact, informing ourselves of the properties of the tools with which Nature works, our own efforts and performances must be imperfect, and come short of the mark. A number of instances of draining, collected both previously and subsequently, and published by others as well as myself, induced in me a firm belief in a very early-formed opinion, that the general drainage then carrying on in this country was of a depth too shallow to realise the valuable results which a given expenditure of money was capable of effecting. Growing experience, with extended observation, have only served to strengthen my confidence in the superior efficiency of a deeper system of drainage, and the fortuitous discovery of the simple cylindrical pipe-conduit came in aid of those agriculturists and drainers whose convictions and practice were enlisted in the same cause. The Society owes to Mr. Pusey the first announcement that there were drain-tiles of that form in use, in his paper 'On the evidence on the antiquity, &c. of thorough draining,' published in the May Journal of 1843; and in the same year, at the Derby show, Mr. John Read exhibited a few specimens of pipes. This was followed by an investigation into the use and merits of pipes made at the instance of the Council by myself in Kent, and reported in the second part of the Journal of the same year. There existed only at that time a machine of a rude kind for manufacturing drain-pipes, but through the wide-spread information conveyed by the pages of the Society's Journals, and the prizes offered by it for superior machines, we have arrived, in the short space of three years, to that agreeable dilemma which actually renders the selection in our show-yard of the most meritorious pipe machine a matter of no little difficulty. From a machine having the faculty of producing about 1000 feet of pipes per diem, we have advanced, in less than three years, to the faculty of making 20,000 feet in the same time; in truth, the power of production by many of these machines is considerably, though usefully, greater than the requirements of any tilery. It may be also asserted that we have, during the same period, vastly enlarged our knowledge of the art of draining. We have come to consider, scientifically, what is meant by draining. Instances of the truest kind for guiding our judgment have been elicited from the practice of many farmers living in different counties, and occupying different kinds of soil; we have had collected and placed before us in juxtaposition the fact and the effects of drains made at different depths, not only in similar soil, but in the same field; we have the fact

before us, well ascertained by various careful observers and practitioners, that lands which have been drained to a certain depth without effecting a cure of wetness, have entirely lost their dropsical habit when under-drained to a greater depth. The evidence to my mind is irresistible that a less depth of drain than four feet in any soil will not be accompanied by those beneficial results which we obtain at that, and in some soils by a still greater depth and if time permitted I should not doubt the bringing before you a mass of evidence, drawn from my own practical experience, as unimpeachable as it would be convincing, that drains executed to these depths are not only the most efficient, but the most economical, when the conduit is formed of cylindrical pipes.

Before, however, entering on the detail of one or two interesting and peculiar examples of the effect of deep drains, I am desirous of making known to the Society the opinions of an excellent author, the third edition of whose work was printed in the year 1652, and in which the recommendation and theory of deep drainage, as applied by him to water meadows and swamps, are so clearly and powerfully laid down, that it would be difficult to give them in better language. It is right, too, to assign the merit of discovering, or of the earliest assertion of sound practical principles to whomsoever we may consider to be entitled to the praise. The author of this work was a Captain Walter Bligh, signing himself "A Lover of Ingenuity;" it is quaintly entitled 'The English Improver Improved; or the Survey of Husbandry Surveyed:' with several prefaces, but specially addressed to "The Right Honourable the Lord General Cromwell, and the Right Honourable the Lord President, and the rest of the Honourable Society of the Council of State." In his instructions for forming the flooding and draining trenches of water meadows, the author says of the latter: "And for thy drayning trench it must be made so deep that it goe to the bottom of the cold spewing moyst water, that feeds the flagg and the rush; for the widenesse of it, use thine own liberty, but be sure to make it so wide as thou mayest goe to the bottom of it, which must be so low as any moysture lyeth, which moysture usually lyeth under the over and second swarth of the earth, in some gravel or sand, or else, where some greater stones are mixt with clay, under which thou must goe half one spade's graft deep at least. Yea, suppose this corruption that feeds and nourisheth the rush or flagg should lie a yard or four foot deepe, to the bottom of it thou must goe, if ever thou wilt drayn it to purpose, or make the utmost advantage of either floating or drayning, without which thy water cannot have its kindly operation; for though the water fatten naturally, yet still this coldnesse and moysture lies gnawing within, and not being taken clean away, it eates out what the water fattens; and so the goodnesse of the water is, as it were,

riddled, screened, and strained out into the land, leaving the richnesse and the leanesse sliding away from it." In another place he replies to the objectors of floating that it will breed the rush, the flagg, and mareblab; "only make thy drayning trenches deep enough and not too far off thy floating course, and I'le warrant it they drayn away that under moisture, fylth, and venom as aforesaid, that maintains them, and then believe me, or deny Scripture, which I hope thou darest not, as Bildad said unto Job, 'Can the rush grow without mire, or the flagg without water?' Job. viii. 12. That interrogation plainly shewes that the rush cannot grow, the water being taken from the root; for it is not the moystnesse upon the surface of the land, for then every shower should increase the rush, but it is that which lieth at the root, which, drayned away at the bottom, leaves it naked and barren of relief."

The author frequently returns to this charge, explaining over and over again the necessity of removing what we call bottom-water, and which he well designates as filth and venom, observing, "I am forced to use repetitions of some things, because of the suitableness of the things to which they are applied; as also because of the slowness of people's apprehension of them, as appears by the non practice of them,—the which, wherever you are so drayning and trenching, you shall rarely find few or none of them wrought to the bottom." As to the distance between the draining and floating trenches, he prescribes no certain rule, saying, "If the land is sounder and drier, or lieth more descending, thou mayest let it (the water) run the broader; and as thy land is moyst, sad; rushey, and levell, let it run the less breadth or compasse;" thus exhibiting a far more correct and intimate acquaintance with his subject than is often to be found among the water meadow artificers of the present day, my opinion being that many of these meadows have been converted into swamps, for want of a systematic and deep under-drainage. Our author gives a most just account of the cause of those isolated boggy places and swamps so often formed on the slopes of hills, and at their foot, and describes the mode of treating them, so as to effect a perfect cure, which coincides with the best practice of the present day; but I fear to be tedious, and therefore refrain from this quotation.

For all drainage purposes he reprehends shallow trenches, observing, in respect to bog-drainage—"But for these common and many trenches, oft times crooked too, that men usually make in their boggy grounds, some one foot, some two, never having respect to the cause or matter that maketh the bog; I say, away with them as a great piece of folly, lost labour, and spoyle, which I desire as well to preserve the reader from, as to put him upon a more profitable experiment; as to destroying the bog, it doeth just nothing, only taking away a little water which falls from the

heavens, and weakens the bog nothing at all, and to the end it pretends is of no use." Finally, he describes, admitting such a work to be more expensive, but more efficacious and durable, the use of deep covered drains, placing at the bottoms of the trenches "good green faggots, willow, alder, elm, or thorne," or in firmer stuff, "pebble stones or flint stones, and so fill up the bottom of thy trench about fifteen inches high, and take thy turf and plant it as aforesaid, the green soard downwards, being cut very fit for the trench, so as it may joyne close as it is layd down, and then having covered it all over with earth, and made it even as the other ground, waite and expect a wonderful effect through the blessing of God." He prescribes also, in all cases excepting for water meadows, the driving the drains right up and down the fall of the land. In this account of draining water meadows and swampy lands, one cannot but recognise very sound principles, and these are represented by Captain Blith as having been put into practice by himself, copied by others, and as having raised the value and rent of land so treated from a few shillings to two, three, and four pounds per acre. There is no indication in this work of any systematic plan of under-draining generally wet and retentive soils, but the author seems, nevertheless, to have been thoroughly penetrated with its importance, referring to the "incredible expense" it would occasion, and he prescribes in this difficulty the ridging up wet clay lands, or the laying them in balks. As no instance or "precedent," as Captain Blith terms it, of any general under-draining is referred to by him, we may, I think, conclude that this practice has had its origin within the last two hundred years, struggling onwards to perfection through the difficulties presented by the absence or expensiveness of good materials wherewith to form permanent water-conduits.

In the course of my operations as a drainer, I have met with, or heard of, so many instances of swamp drainage executed precisely according to the plans of this author, and sometimes in a superior manner—the conduits being formed of walling stone, yet at a period long antecedent to the memory of the living—that I am disposed to consider the practice of deep drainage to have originated with Captain Blith, and to have been preserved by imitators in various parts of the country; since a book, which passed through three editions in the time of the Commonwealth, must necessarily have had an extensive circulation, and enjoyed a high renown. Several complimentary autograph verses, written by some imitators and admirers of the ingenious Blith, are bound up with the volume, which I beg to put into your Lordship's hands as proof of the statements I am making. I find also, not unfrequently, very ancient deep drains in arable fields, and some of them still in good condition; and in a case or two I have met

with several ancient drains six feet deep, placed parallel with each other, but at so great a distance asunder as not to have commanded a perfect drainage of the intermediate space. The author from whom I have so largely quoted is the earliest known to me, who has had the sagacity to distinguish between the transient effect of rain, and the constant action of stagnant bottom water in maintaining land in a wet condition. It is this subterranean water, as it may not be improperly termed, to which excessive and injurious wetness is attributable, and if such water be not removed and kept down at a depth exceeding the power of capillary attraction to elevate it too near the surface, no drainage can be efficient. It is this force combined with the absorbent power of the earths which chiefly maintain those soils in a sufficiently moist state for vegetative perfection, on digging into which we do not discover any free water within several feet of the surface. The effect of rain is to thoroughly moisten such soil, gravity carrying down below the excess, or that portion which the soil cannot absorb or retain. Evaporation takes place from the surface of the land, and as each atom of moisture is taken up into the atmosphere, its place is supplied by another atom communicated by the contact of the particles of soil, the more superficial acting on the deeper particles like so many pumps to elevate the water and supply the loss. In this way the deep rich loams, to which I have before adverted, as so rare and so coveted, are maintained in a nearly constant condition of moisture suitable to the necessities of plants. It may and does, though rarely, happen, that even such soils during long-continued droughts suffer, that is, become too dry; but the attentive observer will notice a very beautiful and powerful provision of nature to prevent excessive dryness. During the night evaporation from the surface of soil commonly ceases, to commence again when the rays of the sun impinge upon it; but capillary action is constant and of equal intensity both by night and by day, so that we have, on the average, twelve hours per diem of the sun's influence to produce evaporation, and twenty-four hours of capillary action to supply the loss from below, and maintain a tolerably uniform hygrometric or moist condition of the active soil. It is, I believe, consistent with the universal opinion that drained lands do not burn, nor suffer from drought so soon or so much as those soils which are wet at all periods of the year, except during the hottest months. This phenomenon is explained by the fact of a retentive soil swollen by water contracting so much by the loss of its water, that it is almost inaccessible to air from which to obtain moisture. After drainage the mechanical texture of such soils becomes gradually changed; pulverization takes place in the subsoil in a manner precisely similar to the change we see produced in fresh

turned-up soil well exposed to the atmosphere; such change of texture in the mass below is doubtless slower than in the superficial soil, but it is equally certain to occur.

Perhaps no more striking illustration of the great importance of securing free ingress to air and free egress to water in the mass of the soil can be given than that which is derived from the fact that by allowing land to rest without cropping it—in short, by fallowing it—fertility is renewed, and this effect is produced solely by supplies furnished from the inexhaustible magazine of the atmosphere. The atmosphere is our cheapest, it is a boundless storehouse of manure: then why not let it freely and deeply into our soil? The earnestness with which I appeal to the landed proprietary of Britain to drain more deeply and abandon the ofttimes abortive and at all times incomplete system of shallow drains, is derived from the indications of experience; and to those well informed of the superior economy and efficiency of the deeper system, it is painful to behold the sums of money daily buried in the soil with such good intentions, but with comparatively so little useful effect. In respect, however, of the depth at which drains may, with a certainty of action, be placed in a soil, I pretend to assign no rule; for there cannot, in my opinion, be a more crude or mistaken idea than that one rule of depth is applicable with equal efficiency to soils of all kinds: the same remark applies in regard to assigning any common rule of distance between drains, which may be greater or less according to the depth of the drains, and the texture of the particular soil. It must be self-evident that water will flow through a gravel, or a sand or a loam, with less obstruction to its passage than through a clay, and easier through one clay than through another containing different proportions of silica and alumina. There are also many other properties of soil to which the drainer has to pay attention in determining depth and distance, such as tightness or compactness, uniformity, or intermixture of soils of a different texture in the line of his drains in the same field, &c. &c. All these circumstances will affect both his practice and the cost of the work. It consists with my own practice at the present time, that drains are being executed at depths of from 4 to 6 feet deep, according to soil and outfall, and at distances varying from 20 to 66 feet; complete efficiency being the end studied, and the proof of such efficiency being that, after a due period given for bringing about drainage action in soils unused to it, the water should not stand higher, or much higher, in a hole dug in the middle between a pair of drains than the level of those drains.

The cost of drainage is in like manner affected by the texture of soils, their stonyness, &c.; and rates of work are being paid, varying from 3*d.* to even 1*s.* 6*d.* per rod (5½ yards), causing the

cost of drainage per acre to vary from 2*l.* to even 5*l.* per acre, according to circumstances.

The following is an instance of the utility, the necessity I ought to say, of well examining soil—of ascertaining, in fact, what we have to deal with before commencing drainage. I was invited in February last to visit the property of the Duke of Wellington, at Stratfield-Saye. I found a particular grass-field, which it was desirable to drain, very wet, and it was thought that no drainage deeper than about 2 feet would have any effect upon it, as drains in other parts which had been made 3 feet 6 inches deep had not effected much more good than the shallower ones. It was also thought that the mass of clay beneath would be found almost impervious to water, as cracks had only opened in hot seasons to about 15 inches deep. However we had the turf and mould borne off a space of about 5 feet square and 22 inches deep, when a bed of yellow plastic clay appeared. Into this bed, which was soft and easily worked by the hand, a hole was sunk. But a very slight quantity of water oozed into the hole until we reached about 4 feet 3 inches, when the hole rapidly filled with water. It was still clay, but evidently of a more porous nature, and there a mass of free water resided. It was apparent that the cause of the upper clay and surface soil being so wet in defiance of the shallow drains, was now discovered, for as the upper clay reposed on what, relatively, may be called a pillow of water below, the capillary force, always in action, continually sucked up this water, and supplied the incumbent soil with a perpetual excess of fluid. The shallow drains might have done their duty in removing the water of rain—the surface water—but they could in nowise affect the liberation of the bottom water. An experimental drain was then made, 5 feet in depth and 350 yards long, laid with 1½ inch bore pipes. Clay was puddled in over this line of pipes up to 2 feet 6 inches from the surface, and another line of similar pipes was then laid; so that we had a shallow and deep drain in the same trench, the object being to measure the relative discharges of water from each, and the lower drain was puddled over to prevent as much as possible the top water from mixing with the bottom. The result was that the bottom drain discharged, from the commencement, a stream averaging one gallon per minute during seventy-six days, being equal to nearly 5 tons every twenty-four hours. The run then rapidly diminished, and speedily came to drop only. A second 5-feet-deep drain had been made 36 feet distant, so as to insulate a space of land on one side of the experimental drain, and it will be found that, taking the length of 350 yards with a breadth of 12 yards as affording water to the bottom drain (6 yards on each side of it), no less than an area of 4200 square yards of water, 5½ inches

deep, had been removed by this one drain. The upper line of pipes answered to rain and removed it, but the observers do not think that any, or much, of this water has reached the lower drain. The land is now reported to me as giving way in cracks to a greater depth than formerly, so that an efficient drainage may be ultimately expected. The following is an analysis of the clays in question taken at 22 inches and 4 feet 6 inches deep respectively beneath the surface, by Mr. Phillips.

	Clay at 22 inches per cent.	Clay at 4 feet 6 inches per cent.
Silica	59·0	72·9
Alumina	23·5	13·4
Peroxide of iron	8·1	6·6
Carbonate of lime	1·0	0·8
Water, with a little carbonaceous matter, slight traces of magnesia, and sulphate of lime and loss	8·4	5·5
Carbonate of magnesia	0·0	9·8
	100·0	100.0

This is only one out of numerous examples which I could cite of the lower clay of a field being more porous than that nearer the surface. Beds of gravel, sand, or mixed earth also often prevail under superficial clay at depths not too great to allow drainage to be made at distances considerably wider than if the drains were laid in the clay, effecting thereby the removal of the subterranean water, permitting the descent of rain water, and causing a less outlay of money.

The capillary force, or *succulency*, of soils varies greatly, and is often very noticeable. It has occurred to me in digging test holes previous to drainage, to find the water standing in them not nearer the surface than 3 feet, yet the surface soil has been so wet that water would drop from it on squeezing with the hands. This exhibition would determine me to bleed such soils to the depth of 5 feet at least, and such drainage has been accompanied with complete success.

Although I am not a practical farmer, I think that I may very confidently recommend to farmers the laying land absolutely flat after efficient drainage. It is the practice of many good agriculturists in the stiffest clays, who consider that even a crease left on the surface is injurious to drainage. In addition to several recorded opinions on that head, I will quote a letter recently received from Mr. Andrew Thompson, the intelligent bailiff of the Right Honourable Charles Arbuthnot, who has drained part of his farm—a very strong clay—4 feet deep, and whose account of the effects is to be found in the last Journals.

Woodford, July 4, 1846.

Dear Sir,—On the arable land, which we have drained to the depth of 4 feet, I have not found it necessary to maintain any open water-furrows. I am not at all an advocate for water-cuts, or surface-drains of any description on arable land, it being my belief that when they are used for the purpose of carrying off the water after heavy rains, they are also the means of washing away a quantity of fine soil, which might otherwise be retained on the land. I believe that if even the most retentive of soils were drained to a considerable depth, and rendered friable by the aid of Read's pulveriser, there would not then be any use of open water-furrows on that description of land. In reply to your other question I have to say, that adjoining one of the fields, which was drained to the depth of 4 feet, is a field of the same subsoil (a strong blue clay), which was only three years ago drained in the old fashioned way of "shallow draining," I have frequently observed that after heavy rains the water began to run first from the deep drains, and that when the shallow drains did run, they did not appear to me to discharge the same quantity of water to the same quantity of land as the deep drains.

I was quite against draining land so very deep until I saw the great advantages derived from it.

Yours, &c.

Andrew Thompson.

The last remark made Mr. Thompson, as to the deep drains giving issue to rain water, in land under precisely similar circumstances, before shallow drains, agrees with the observation of a great number of farmers, whose land has been so drained; and it would be difficult to cite a more apposite proof, I think, of the superior condition into which the mass of the soil is brought by deep drainage. That this should occur in a field where shallow drains exist in the neighbourhood of deeper drains, and within their influence, would be naturally expected, as the water keeps on descending below the level of the higher and until it reaches the level of the lower vents, where it meets with free water, and then begins to travel horizontally to the drain. The reason, however, why the deeper drain in one field should begin to discharge before another and a shallower drain in another field, or in a very distant part of the same field, having precisely similar soil, is not quite so obvious. I have this day received from a tenant farmer in Yorkshire an account of an observation of his, that a 4 feet drain began to run five minutes earlier after rain than another drain 16 inches deep at a distance, but in the same field. Some experiments are being made which may elucidate this action, which tells so favourably for the deeper drainage.*

* See the Report of the Evidence given before the Select Committee of the House of Lords last year, for information on this head. Mr. Robert Neilson's statement of the result of intermingling deep and shallow drains in the same field is highly instructive and to the purpose.

There are some causes of stoppage to subterranean drains, though fortunately few and limited in their extent, with which every drainer should be acquainted, and prepared to encounter and vanquish, as he best may. The first and most extensive evil of this kind to which I will refer, is the deposit of a substance of an unctuous sticky nature, in drains laid in soils containing much ferruginous matter. On this point I was particularly questioned by his Grace the Duke of Richmond, chairman of a Select Committee of the House of Lords, appointed last year "to inquire into the expediency of a legislative enactment being introduced to enable possessors of entailed estates to charge such estates with a sum, to be limited for the purpose of draining and otherwise permanently improving the same." I was asked, "Do not stone drains invariably clog if there is water in them impregnated with iron?" My reply was, "I have no doubt that the ferruginous matter, such as I have often seen accompany the water of drainage, would stop up stone drains;" and, in conversation, his Grace informed me, that he had estates in Scotland infested to such a degree with ferruginous matter, that the deposit of iron in drains seemed an almost invincible obstacle to the drainage of these lands. Since that time, and in various parts of England, my attention has been practically and specially required to discover the cause, and, if possible, a cure for this disease. It may not be thought tedious that I narrate what I know on this subject, as there are thousands of acres of land, the drainage of which depends on discovering some means of rendering it permanent.

When applied to by Sir Robert Peel last autumn to drain some portions of his estates at Drayton Manor—and he knew that my system consisted in the use of small pipes in preference to other conduits—he earnestly called my attention to this cause of stoppage, which had been a continued source of vexation, expense, and defeat, in draining the park and other parts of the property. Sir Robert accompanied me throughout the grounds to be first drained, and showed me the evidences of this red deposit at the mouths of drains, and the spewing masses of it on ditch banks, &c., leaving me to deal with the enemy according to my judgment. It will be conceived that I felt the full force of the difficulty, and there was but little experience, so far as I knew, of the use of small pipes in soils similarly infested. Yet I had confidence in pipes, as preferable to all other conduits, from the compression of the run of water into the smallest required volume, and therefore as more likely to prevent deposits from occurring or accumulating than larger conduits. I was acquainted with one case, and only one, in which very small pipes, an inch bore, had been used, and have continued to act well for several years, without obstruction, in a boggy soil charged with iron, though the

ditches into which the pipes, always running full bore, discharged their water, require clearing once or twice a year to keep them open. I also felt additional confidence in the sufficiency of small pipes, as I proposed laying them with collars, which would further help to cover and diminish the size of the crevice between each pair of pipes, and close it against the entrance of solid matter. However, I devoted an entire week to the examination of old drains, many of which were quite stopped up with earth and iron deposit mixed; of these some were composed of the common horse-shoe tiles laid without soles, and others with soles. The drains through which water was continually running were chiefly open, having great quantities of the deposit at their mouths, and one drain, formed of 6-inch pipes, conveying much water, exhibited the iron copiously as a precipitate when the line was broken and a pipe removed, which exposed the water to the atmosphere; cesspools communicating with the atmosphere at top, and into which some drains entered, were also lined with deposit. I examined several drains serving as mains, and particularly at their point of junction with minor drains, and I found one of these drains about 6 feet in depth, and very well constructed, to be nearly closed with what appeared to be a pure specimen of the deposit, having the red colour of peroxide of iron, and of a pasty texture. This particular mass of deposit had occurred at the junction of a branch with the main, about 30 or 40 yards from the higher end or origin of each drain, and where the run of water would necessarily be greatly less than as it approached the outfall; and I have found at Drayton Manor, and many other places where ferruginous matter abounds, that stoppage from its deposit is much more frequent towards the higher than nearer the outfall end of a line of drain; and for the very obvious reason, that the flow of water there is greatly less both in quantity and velocity—and consequently of less force than it is as it approaches the end of its course. This specimen was analysed by Mr. Richard Phillips, of the Geological Museum, Craig's Court, London. Mr. Phillips at once told me it was peroxide of iron, but I wished it to be analysed that I might know whether, and to what extent, the iron was pure or incorporated with other matter. The following is Mr. Phillips's report of its nature and of the manner of its production:—

"*Museum of Geology*, 13*th Dec.* 1845.

"I have submitted the deposit occurring in the draining-pipes to analysis, and I find it to consist of, after drying—

Silica and alumina, with a trace of lime .	49·2
Peroxide of iron	27·8
Organic matter	23·0
	100·0

"The large amount of peroxide of iron shown in the above analysis, appears to me to be in consequence of the iron existing originally in a lower state of oxidation, in which state it has been dissolved by carbonic acid, and formed by the decay of organic matter in the soil, and then carried away by the drainage water; when by subsequent exposure to atmospheric air it has been converted into insoluble peroxide. The other ingredients in the deposit would appear to have been carried down mechanically, in consequence of their existing in a very minute state of division."

It thus appeared from the analysis that only 27·8 per cent. of the deposit consisted of iron, and that the remainder, nearly three-fourths of the whole, consisted of foreign matter. This analysis powerfully fortified my hopes that the drains I was making might remain permanently open, if their mechanical structure were such as to admit water only, and no other earthy matters than such as might be chemically dissolved, in which case it was apparent that I should reduce the enemy to be contended with by nearly three-fourths of his strength, and direct against him, for expulsion, a more concentrated stream of water, by reason of the smaller dimensions of the conduit. Between November last and the present time some miles of drains have been executed in the soils referred to, abounding with bog-iron ore, locally called "pox-stone," the same as I have met with in North Devon under the name of "black-ram," and in Somerset under the title of "iron-mould." In other parts it is called by its proper name. It occurs in masses, both large and small, sometimes in beds. It is intensely hard, and interferes much with both the economy and despatch of digging the drains. It is the protoxide of iron of the chemists, and furnishes by its fine dissemination in the soil the matter dissolved by means of carbonic acid in the water which enters the drains, becoming peroxide in the manner described by Mr. Phillips. The term iron, or rust of iron, would convey to the mind an idea that this ferruginous matter was heavy, and would quickly settle; but when it is considered that all substances chemically dissolved in water and precipitated, are infinitely fine, each atom is, in a practical sense, light, and easy of removal; and, in reality, this substance is seen to issue from the mouths of drains in the form of light, flocculent, floating little masses, which settle when the water is quiet, or are easily brought to rest by stones, grasses, &c.; and this has actually given rise to a notion with some people, that it was a vegetable substance, and grew in drains.

Up to the present time not a trace of this ferruginous matter is to be discovered at the outfall of any one of the pipe drains laid at Drayton Manor; there is not even a stain of its presence visible on the ends of any of those pipes which discharge into open ditches, and where it might be expected to exhibit itself; nor have I yet

observed any deposit of the substance in the ditches. So that the result is very encouraging. The time, however, has been too short to permit us to indulge in absolute certainty as to their permanent action; yet I may mention one or two circumstances as confirmatory of the fact that earthy matter does not enter the pipes, and that therefore nothing has to be dealt with but the iron. There is no appearance of any sand or other earthy bodies having accompanied the water of drainage, which is brilliantly clear; and in one field where I had the opportunity of continuing a line of pipes through the field into a head of water which I could stop out, or allow to flow through the drain 290 yards long, at will, no sand was washed out by it, thus giving proof that none had entered the drain with the water of drainage. I do not feel to be thoroughly or sufficiently acquainted with the phenomena attending this drainage, for although my previous confidence in the non-transmission of earthy matter by the collared pipes has been strengthened, as well as the expectation that the flow of water in the confined channel would sweep out any fine rust of iron which might be deposited therein, I do not yet, however, understand the absence of the appearance of iron deposit at the outfalls of these drains. Time and observation, assisted by an analysis of the issuing waters, which has already been commenced, and the drawing the attention of chemists generally to the subject, may, I hope, by enabling us to detect causes, teach us how to improve effects. The subsoil generally in Drayton Manor Park consists of gravel intermixed with fine and very heavy sand alternating with, or broken in places by, a marly clay very retentive of water. It contained much water, our test holes standing full in the winter, or within 18 inches of the surface throughout. It was chiefly by the pickaxe that the trenches had to be opened, spades being of little use in the gravels. The sides fell in and closed so much that it was difficult, and, in some parts impossible, to keep an entire line of drain open before the pipes were obliged to be laid, so that the worst parts had to be done by instalments, the pipes being laid and covered up as the work proceeded—for, if not so done, the spewing sand was forced up from the bottom and through the sides by the pressure of water. All was secure, however, when the collared pipes were laid and covered in. One drain, about 105 yards long, was laid in a quicksand, by using inch pipes completely sheathed in another larger pipe, and no packing or cover was employed. This drain, which is about 6 feet deep, has never exhibited, at its outfall, a grain of sand; the water is beautifully pellucid, and has maintained a discharge varying, however, with rain or drought, of about two gallons per minute. I conceive this method of sheathing pipes to be capable of forming a permanent drain through any species of quicksand or loose soil; packing may be a useful and even necessary adjunct

in certain very fluid and fine media, but when a drain thus formed is carefully laid and filled in, my belief is that it will resist the entrance of all matter, except water. To use the apt expression of one of my workmen, "nothing else can get in when the water sighs into the drain so quietly."

Another cause of obstruction to drains is the entrance into them of the roots of trees and plants. Of the former several cases have been reported to me as having occurred, and probably no species of close under drain, yet constructed, can be considered to be absolutely safe from the roots, if laid within the range of their travels; and the great distance from the parent tree to which roots will travel in search of food, is well known to every agriculturist. It would be venturing too much to say that a root will not enter drains by any, even the smallest conceivable, crevice or pore, which will admit water; for cases have been mentioned to me almost justifying the belief that roots have insinuated themselves through Roman cement. They seem, however, to be very capricious and choice in their attacks, for I have seen drains which have continued perfectly free in their action for years, adjoining fences and plantations, whilst a drain, at a greater distance, has been choked by roots. In the two or three cases observed by myself, I have found that a single thread-like root alone has entered, and then worked its way up against the run of the water, increasing into a hairy mass, something like the brush of a fox, and growing in length sometimes to several yards, until it closes the drain as completely as if it were stopped full of clay. In situations where drains must be laid near to trees, I would advise the keeping as far off as circumstances permit, and the providing each row of pipes, if joining a main, with a cess-pool at their junction, in order that the discharge may be visible and examined occasionally, which would soon detect a stoppage if it occurred. But it will be wise in all cases, if people will have hedge-row trees, that the drainer so plan his operations as to keep as wide of them and fences as possible—but, better still, to get trees felled wherever they occasion a feeling of doubt as to their affecting the permanency of the drainage, or cause it, in respect of the direction or depth of the drains, to be other than complete. If trees, as in parks, are in the way of drains, I advise the sheathing of the pipes on approaching within 20 yards, and I frequently diverge from the line and pass round the tree to regain the true line of drainage.

With stoppages from the roots of plants I have only very recently become acquainted, but this evil does occur, though fortunately it is of very rare occurrence. The first case known to me took place this year in a field on an estate of Mr. W. Wolryche Whitmore, at Lebotwood, in Shropshire. A tenant of his laid a pipe-drain last March in a boggy piece of ground very wet and spongy, which

which was sown with turnips. The drains were found in many places to be completely stopped with very fine roots in October. It seems to be difficult, indeed impossible, to pronounce from what plant these roots proceeded. I sent specimens of them to Professors Lindley and Daubeny, who kindly examined them, but neither of these botanists is able to decide on the parent plant, to which the roots unfortunately were not traced when the pipes were taken up. The drains were shallow, not exceeding 2 feet 6 inches deep anywhere. The boggy soil contained many sorts of weeds, as crowfoot, coltsfoot, rushes, and docks, of which there was abundant evidence when I was on the spot some weeks afterwards. The pipes sent me contained much earth, which had got into them, with the roots, and I understand that several of the pipes were almost stopped with soil alone, but it is also true that others, in which the roots had worked, were free of earth. From all the evidence I could collect on the spot, I am disposed to consider this stoppage by roots to have originated in bad laying of the pipes by the farmer, and insufficient depth in a very foul piece of land. It is however a case of warning, and one to excite vigilance of observation. I have now a drain laid deeply in the same soil with pipes collar-jointed, and other drains to test any difference in future action and phenomena.

It is important that every case of the stoppage of drains from the entrance of roots should be well investigated; but we may rest quite satisfied, from our long experience of under-drainage, that instances of this evil will only be of casual, and, probably, of merely local occurrence. With the exception of the one case cited, I have not heard of the occurrence of a single case of root stoppage in pipes; but it is evident that if the roots of weeds or cultivated plants were in the habit of preferring to burrow in a drain rather than in the bed of the soil, a pipe drain would be as liable to be choked as any other form of drain.

I will now refer to one or two natural aids to drainage.

Besides the porosity of soils, by which they receive and part with water more or less readily, according to their openness or retentiveness, there are other adjuncts or means auxiliary to its reception and discharge. It has not occurred to me to excavate many clay soils for drains, in which there are not perceptible what experienced and observant drainers aptly call water veins. The clay is divided, as it were, into plates, masses opening or parting from each other like the leaves of a book, between which, thin as the vein is, an evident passage of water has taken place. These partings may have been originally occasioned by vertical cracks from the surface, which have never entirely closed again, and so served to conduct away some of the rain water to more porous and absorbent strata. It is a matter of fact that in all clays in which these water veins

occur in the greatest number, I have found drainage to be effected the most speedily, and I practically use the perception of their presence as some guide to the distance at which I determine to place the drains from each other.

But the most active and potent of the drainer's auxiliaries is the common mining earth or dew worm. The earliest written notice which I have seen of the utility of the earth-worm in drainage is to be found in Mr. Beart's article on draining (Journal, vol. iv. p. 212), in every word of whose remarks I concur. Earth-worms love moist but not wet soils; they will bore down to, but not into water; they multiply rapidly in land after drainage, and prefer a deeply dried soil.

On examining with Mr. Thomas Hammond, of Penshurst, Kent, part of a field which he had deeply drained, after long previous shallow drainage, we found that the worms had greatly increased in number, and that their bores descended quite to the level of the pipes. Many worm bores are large enough to receive the little finger, and it is possible that one worm has several bores for his family, and refuge holes from rain. I have very recently found worms twisted up into knots, and berthed in a nidus formed by the side of the vertical bore, and in communication with it by a lateral hole about an inch long, forming in appearance a comfortable retreat.

My valued and much lamented friend, Mr. Henry Handley, informed me of a piece of land near the sea in Lincolnshire, over which the sea had broken, and killed all the worms—the field remained sterile until the worms again inhabited it. He also showed me a piece of pasture land near to his house in which worms were in such numbers that he thought their casts interfered too much with its produce, which induced him to have the field rolled at night in order to destroy the worms. The result was that the fertility of the field greatly declined, nor was it restored until they had recruited their numbers, which was aided by collecting and transporting multitudes of worms from other fields.

The great depths into which worms will bore, and from which they push up fine fertile soil, and cast it on the surface, has been admirably traced by Mr. C. Darwin, of Down, Kent, who has shown that, in a few years, they have actually elevated the surface of fields by a layer of fine mould several inches thick, thus adding to the pabulum of the grasses. His experiments were made at Mr. Wedgwood's, of Etruria, and are recorded in the 'Gardener's Chronicle,' of April 6, 1844. Mr. Darwin's researches are entitled to the strictest credibility. Here are some specimens of warp soil now undergoing drainage by me on an estate of Mr. William Marshall's, M.P., near Patrington, fourteen miles east of Hull, and opposite the well-known tract of land, reclaimed likewise from the

Humber, called Sunk Island. When first examining this soil for drainage, I was struck with the astonishing number of fine vertical holes penetrating the warp to its full depth in some places 8 to 10 feet. These holes were evidently not the work of earth-worms, being of a much smaller bore, and worms abound in that soil, and were at work in their own fashion, though no other living creature was discernible. Very many of these minute holes seem to be fully appropriated by the fine roots of plants, which descend into them, and thus find easy access to moisture and air.

On further investigating into the origin of this net-work of holes, it was traceable beyond a doubt to the existence and activity of myriads of small marine animals, having numerous legs, and minute eel-like looking fish working in the mud of recent deposition. The tidal stream from the Humber which is conducted upon the warping grounds, and let out again with a retiring tide after the deposition of its solid matter, does not destroy the life of these creatures, nor close their cylindrical habitations. On the retirement of the water they are to be seen ceaselessly occupied in working up and down their holes further to maintain and elaborate them against the next invasion. The death of these amphibious animals no doubt occurs when the process of warping terminates, and the soil solidifies, but their holes remain entire and open from the top to the bottom of the mass, serving to admit air and moisture, and to pass the water of rain in finely divided streamlets to the drains, and the earth-worm finally establishes himself in a soil easily penetrated and most congenial to his mining habits. In the field of warp first begun to be drained on this estate, I have set out the drains at about 50 feet asunder, their depth varying from 4 to 6 feet, as outfall permits; but it is probable, as experience is gained of the draining faculty, that we may see fit to diminish the number of drains, and so increase their distance from each other in these soils. The alumina of the Humber warp is very fine and very retentive of moisture. Water appeared at 18 inches below the surface after a month of powerful evaporation and drought in May and June of this year, and copious streams were discharged from the deep drains. In its original state of wetness, but under circumstances of drought, this soil cracks widely and deeply like the stiffer clays, so that it seems to possess every facility for the most complete drainage, whilst its faculty for absorbing moisture from the air, and by capillary attraction from below, are of the highest order, which must vastly aid in conferring upon it the fertility well known to attach to warp lands.

But the quality of warp varies greatly, according as the deposit takes place in different parts of the same stream, and at greater or less distance from the warping river's mouth. I cannot per-

haps mention a more remarkable instance of the difference in the properties of warp, than what occurs at Bridgwater, in Somerset. The river Parrot is famed for the almost evergreen fatness of the pasturage bordering its banks, lands which were formed originally, it may be presumed, when that river was an estuary of the sea far inland. Its deposit immediately in the neighbourhood of Bridgwater has occasioned a great manufacture of very superior bricks and earthenware; and there is one article of almost universal domestic use, called the Bath brick, for cleaning knives, &c., made at Bridgwater only, and it is singular that the sludge or mud from which these bricks are made is collected from the river Parrot's banks, within about a mile above and a mile below the town of Bridgwater. The banks of those particular two miles of the river alone afford the precipitate fit for the manufacture of the Bath brick. The deposit formed, whether more inland or more seaward, is found to be unfitted for the purpose. So, in the warped lands formed from the water of the Humber, whether passed immediately from that river, the Ouse, or the Trent, great difference in the quality of the deposit and fertility of the soil in respect of the proportions of clay, sand, and salt is discernible and well known.

Great difference also exists as to the necessity of draining warped lands, arising from the depth of warp, the character of the subsoil on which the warp is run, and the particular composition of the warp itself in its proportions of clay and sand. Near to the mouth of the Humber it strikes me that there is a much larger proportion of alumina (clay) deposited, in respect of silica (sand) than about Goole, Thorn, and other warping districts. There is no doubt also much more common salt in the composition the nearer to the Humber mouth.

The quantity of salt in which the wheat plant will flourish is curiously illustrated in the warp soils about Patrington, and would be scarcely credited, unless seen. The whole surface of a large reclaimed warp piece on Mr. Marshall's estate was planted with wheat for the first time in the autumn, 1844. When I saw it in the autumn of 1845, the surface of the ground was crystallized all over with salt, evidencing the enormous quantity which the mass of the bed must have contained; yet, from this first crop the tenant told me he had threshed out 24 bushels per acre. The order of culture there, after warping, is to leave the land to the occupancy of what is called the sheep grass, which naturally skins it for three years, when that begins to die off. It is then ploughed up, and sown with rape, allowed to go to seed. This plant is considered to remove the very injurious excess of salt, and great crops of it are obtained. Wheat follows, and after that, any other crop to the farmer's liking, without regard to systematic rotation,

may be produced, and without the aid of manure, for many years.

But the whole of this land is much too wet—it is too salt—and its powers will not be appreciable until after deep and complete under-draining. It appears, however, that the lands warped at a greater distance from the mouth of the river, must be skilfully treated in respect of under-drainage. A complete power of deep under-drainage should be established to withdraw the water and keep it down low beneath the surface when injurious, whilst there should be provided means of sustaining water nearer to the surface and to the roots of plants, when under the influence of such a dry season as was experienced in 1844.

In many of these warped lands means exist to fulfil this end, as water is raised out of the ditches by machinery when in excess, and the height of water in the ditches is maintainable by drawing it from the high land drains. A farmer, residing near to Hatfield Chase, informed me that he considered he saved crops of the value of 1500*l*. in 1844 (when it will be remembered we had fourteen weeks of hot sun, without a drop of rain), by his command of water to charge his ditches. The warped lands are very commonly divided into fields of 10 acres, being squares of 220 yards, surrounded by open ditches, and it is considered that the water is thoroughly drawn out of the soil to the level maintained in the ditches; but this I much doubt, and am satisfied from my observation of these flat warped lands, both in wet and dry weather, that they would be astonishingly benefited by a system combining both sub-drainage and sub-irrigation; but it is possible that the farmer may have reason for not draining this soil more deeply or more completely, unless means are provided for sub-irrigation in droughty seasons.

There has been rather recently introduced by some drainers a practice of making what they term air-drains, with the view of providing for a ventilation of the soil, and also for promoting, as they think, a freer flow of water from drains. As regards the latter point, it is quite certain that such air-drains must be superfluous and unnecessary. The fact of water entering subterranean drains at all is quite decisive as to the universal presence of air in soil, and no one has shown or has attempted to show, so far as I know, its insufficiency. Water could no more issue from a drain laid in the earth, than it could flow from a tight barrel, if air did not press on the surface of the liquid within it. Every one knows how small a vent-hole at the top of a cask suffices to enable us to withdraw a great stream from it at the bottom, and every one knows that the bulk of liquid discharged in a given time is in quantity precisely equal to the volume of air which enters in the same time. The fact of rain-water sinking through the soil is demonstrative of the permeability of that soil to air, as every drop of water which

falls from the heavens must first displace an equal volume of air before it can enter the soil; the water would remain on the surface and never sink if, by reason of its superior gravity, it did not push aside the air in its descent, which it does until it meets with some subterranean level where the earth is saturated with the fluid, and the rain-water then comes to rest, having disturbed and displaced air throughout its whole downward course. And by this action we are led to observe one beautiful provision of Nature for renewing the constituent air of the soil, and I regard it as an argument in favour of deep, as compared with shallow drainage, that a greater bulk of earth is thereby filled with air, and with frequently renewed air.

There are other equally beautiful processes incessantly active to maintain a full supply, and fresh supplies of air in the soil. The continual change of temperature in the soil and in the atmosphere reposing upon it, has its effect; but probably the most potent cause is the unceasing appropriation by plants, or manures, or soil, of some one or other of the three gases of which the atmosphere is composed. A renewal of the particular atmospheric gas consumed, whether it be oxygen, nitrogen, or carbonic acid, must be nearly consentaneous with its use, and is effected by the well-known principle of the diffusion of gases, and without which neither plants nor animals could live.

I have spoken of cesspools as useful and convenient breaks in lines of drains, particularly in the long run of a main, or where several lines of drains converge from two or more directions in one common central point to an outfall. The use of the cesspool in drainage is an old English practice; I have found it in several counties, both North, South, and Midland: it is usually constructed in brick. The specimens now exhibited are made of large earthenware pipes 9 inches in diameter, with a flat tile or foot on which to place them in the soil. This plan will be found advantageous and cheap, as the foreman drainer may fix his cesspools without needing bricks and mortar and a bricklayer. The holes for the receiving-pipes are burnt in these cesspools of the proper dimensions, and the hole for the discharging or outfall-pipe is made a little lower than the holes of the receiving-pipes, so that a drip or fall from the former takes place, and the run of water from each pipe is observable. I have converted these cesspools to another use, viz., that of enabling us to introduce water into the body of the earth, and apply it to what I have before termed sub-irrigation. All the drains of a flat field may be made to issue from a cesspool, into which water from a higher level may be conducted. A cesspool of the same kind is also to be fixed at the outfall end of that field, into which all the drains are conducted. Now, by stopping up the outfall-pipe, and letting water into the

infall cesspool, it is clear that all the pipes ramifying through a field will become filled with water, and that they will disseminate it gradually throughout the entire mass of earth above the level of the drain-pipes, and to any desirable height, as you will observe from the specimens before you, that an outlet-pipe can be formed in the discharging cesspool at any required distance below the surface of the soil, or at the surface. In this manner water may be given to the roots of plants. I refer more particularly to the grasses; and when enough is given, the whole of the water may be removed at will, and a perfect drainage be established. The introduction of these cesspools with pipes also enables us to fill the higher parts of a field with water, which, suddenly liberated, will scour out the lower drains, and prove their condition of openness. The cesspool is also useful when placed close to an outfall into a stream or ditch, in which the water backs up with floods. It may then be furnished with a pipe and valve, here shown, which closes against the rising of the outfall water, and opens as the flood water falls, letting out the drainage water. By these simple means the sedimentary flood water is prevented from entering the drain-pipes, which remain filled with the clear water of drainage. In case of need, the receiving and discharging pipes may be luted into the cesspools with Jeffery's marine glue, but, in most cases, a ramming round with clay will suffice for the purpose, absolute tightness being rarely necessary.

These cesspools, with the various pipes now exhibited, have been made for me by Mr. J. M. Hoskison, of Wilnecote, near Fazeley, Staffordshire. They are admirable specimens of manufacture for truth and smoothness.

It will be observed that I have not introduced to your notice any other kind of drain-tile than pipes, and because I consider them to have the preference over every other description of drain-tiles, and for the following reasons:—

1st. Because the pipe is an entire conduit in itself, stronger than any other form, and capable of being centered and connected by collars, or of having one pipe sheathed within another.

2nd. Because the pipe requires less substance of material for a given strength than any other form into which clay can be put.

3rd. Because the carriage is lighter both to the field, and in the field; a great convenience and economy to the farmer and the drainer.

4th. Because, from their form, when properly laid in the soil, pipes are subject to less derangement from external pressure, or the entrance of earth or vermin, than other forms of drain-tile heretofore in use.

Much has been said and written about the porousness of pipes, as an useful property. I do not see any reason to suppose that

the pipe possesses any greater or less degree of absorbent power than other porous or unglazed earthenware, most of which are more or less porous to water. When properly tested under a pressure of 4 feet of soil, I have found the absorbent power of various pipes, formed of various clays, equal to the passing of about $\frac{1}{500}$th part of the quantity of water which enters the conduit through the crevice existing between each pair of pipes. By so much this property is useful, and I do consider that it assists in drying and giving firmness to the soil in immediate contact with the conduit.

The tools which I now exhibit to you are, I believe, of very superior manufacture, and much cheaper than many very inferior articles made about the country. They are the result of much care and trial in comparison with others, and of cost to myself and the maker, Mr. Lyndon, Minerva Works, Fazeley-street, Birmingham. Here are specimens of the various grafting tools, scoops or hoes of different sizes, and the all-important bottoming or deep-drain spade. A principal advantage in these, as compared with other makers' manufacture, is, that the steel of the tool is plated upon iron, so that as the iron wears away the steel maintains a constant sharpness of edge, and the drainers have not to run away from their work to the grindstone. The pickaxes, &c. are of equally good quality. Here is a tool, called the pipe-layer, recently invented by one of my men for laying a pipe and collar-joint at the same time into a drain. This simple contrivance has saved the use of a boy in laying pipes where collars are necessary. It is suitable for pipes of $1\frac{1}{4}$ inch bore, but may be made to suit any other size of pipe.

With reference to these practical matters, it may be advisable for me to say that in clays, and other clean-cutting and firm-bottomed soils, I do not find collars to be at all necessary; but that they are essential in all sandy, loose, and soft strata.

MISCELLANEOUS COMMUNICATIONS AND NOTICES.

I.—*On the Action of Bones and Acid in the Third Year from its Application.* By R. W. Purchas.

To W. Miles, Esq., M.P.

Sir,—Having promised last year to send you the result of crops grown after turnips with acid and bones, I now beg to enclose the result. You will be pleased to observe these trials are favourable for (at least) the third crop. Some farmers who had a carboy of acid in 1844–5 now want a ton each, so much is this manure extending in this district as well as in Herefordshire.

I am, Sir,
Your most obedient servant,
R. W. Purchas.

Pilstone, near Monmouth, May 19, 1846.

The field manured with sulphuric acid and bones in a liquid state in 1843 (see 'Royal Agricultural Society's Journal,' vol. v. p. 2) was last year planted with *carrots.* The part manured with acid and bones, at a cost of 20*s.* 6*d.*, produced 24¼ cwt. per acre *more* than the part manured with 20 bushels of bones at a cost of 54*s.* per acre.

The field manured with turf-ashes and acid and bones in 1844 (see 'Royal Agricultural Society's Journal,' vol. vi. p. 1) was last year planted wirh *barley.* The part manured with 160 bushels of turf-ashes and acid and bones, costing 12*s.*, produced 6¼ bushels per acre *more* than the adjoining part, manured with 160 bushels of ashes only.

Lindor's Farm, Gloucestershire.

II.—*On the Wheat Midge.* By Robert Baker, Writtle, Essex.

As the wheat crop of last year sustained so much injury from the insect known as the wheat-midge (*Cecydomyia tritici*), I am anxious to submit to the notice of the Council the result of a few observations, derived from an investigation of facts connected with the habits of this insect, by which I had arrived at conclusions independent of the communications of Kirby and other naturalists, who have so ably devoted their talents to the investigation of the subject. In the year 1817, my attention was first directed to it, and from that time to the present I have been able, pretty nearly, to estimate the amount of damage that yearly follows their attacks, and which, I have no hesitation in stating, frequently has amounted to upwards of 35 per cent.

My observations lead me to conclude that the insect cannot well succeed in its object in hot and dry seasons; but that a certain degree of moisture is necessary to enable its eggs to vivify, and this is in

some degree apparent as the insect selects the opportunity of depositing them when the ear of the wheat is only *partly exposed*, and, in almost every instance, before it is fully developed; as during that period it will be found moist and clammy: for, although some flies may be seen upon the wheat-ears that have been some time exposed, it rarely happens that maggots are produced, and then only whilst a certain degree of atmospheric moisture is found to prevail; it is from this circumstance that the ears of the wheat are found infected on one side only, and invariably upon that side that first appears. The time selected by them is from four to six o'clock, or sunset, and from six to eight o'clock in the morning; during those periods they may be seen,—if prevalent, from one to five or six upon nearly every ear of wheat in the act of depositing their eggs, with their heads uppermost and their ovipositors inserted between the chaff of the wheat.

In some seasons the flies are found prevalent only upon the early wheat, and in others upon the later wheat, and it rarely happens that both are attacked extensively in the same year.

In some years the ichneumon flies prevail, and the effects of the wheat-midge are, in some degree, frustrated by them; but in warm and dry seasons, wheat comes rapidly into ear, and soon advances into so forward a state as to preclude injury from their attacks; whilst, on the other hand, in moist, cool, and backward seasons, it comes more slowly into ear, giving the flies greater opportunity of extending their mischief; and this is one of the operating causes why wheat is more productive in early and dry seasons, than in late and moist ones.

I have this year inspected the wheat (whilst coming into ear) minutely, and have, up to this time, seen fewer insects than in previous years; upon investigating a field this evening (June 8th) more than one half of the ears of wheat are fully developed. I have not seen altogether more than three or four flies, and those diminutive, and apparently but just produced from the chrysalis; in the same space (if investigated) last year, a thousand would have been found, as scarcely an ear could be then found with a less number than five or six flies at one time upon it.

I am led to conclnde, from these observations, that in early seasons the wheat comes into ear *before the flies are produced*, and that the later wheat in such seasons only is attacked; and that invariably the very early wheat is not so liable to be attacked as the later; that the flies in ordinary seasons are in greatest number from the 10th to the 20th of June, and rarely seen at all in numbers before that time; and that probably the warmth of the season may vary the time of their coming into life, so as either to anticipate or succeed the earing of the wheat in particular districts. From the habits of the insect it is to be inferred that it cannot travel far, and that those flies produced in situations where wheat was grown the preceding year would perish, unless a succeeding crop of wheat should be grown so as to enable them to perpetuate their species in the succeeding year.

I address these observations to the Council, hoping that the subject may be thoroughly investigated under its direction; for although, with our present knowledge, but little chance appears of mitigating the

damage occasioned by these destructive insects, still we may, by perseverance directed by proper suggestions, probably be able to devise means whereby this great amount of injury may be lessened; and with these impressions I have been induced to address this communication to its notice.*

III.—*On the Preservation of the Swedish Turnip.* By Charles Allix.

Having read and tried every method, I believe, that has been suggested as to the management of the Swedish turnip when taken up previous to the winter, I have never been quite satisfied, as, whether they were placed with a good deal of trouble and labour in long piles, and covered with straw or straw and earth, or in round heaps and covered with earth, or between wattled hurdles, or topped and tailed and deposited in a furrow made by a double mould-board plough and covered by the common plough, there have always been too many rotten to satisfy me. If deposited in a barn or building, it might answer very possibly, as in the case of mangold-wurzel, which I have for several years managed in this manner. I do not remember ever having had a single rotten one. But for Swedes, it would be almost impossible to store any great quantity, so much room would be required—as, for instance, for only ten acres.

However, this year I have tried a plan that does appear to answer, very simple and very cheap; but only having tried it one year, and that year a remarkable one for its mildness, I will not speak positively, and shall be happy to hear any remarks upon the plan, or any improvements suggested by brother farmers.

The plan is this:—In December, or when you please, with the horse-hoe, only one of the side-knives being on, and that knife reversed, you will be able to cut all the tap-roots and scarcely disturb a turnip in the rows. This alone is of use in the spring, even if you do not wish to do more, as it will very much prevent the turnips running to seed, and of course the tap-root from drawing the ground. I tried two rows at a time, *both knives* on; but my man found it almost impossible to hold the in-

* A remarkable fact in corroboration of the foregoing has, since writing the above article, fallen under my notice. A neighbouring farmer having sown a few square yards with foreign wheat, in the midst of a field otherwise sown with red wheat, has directed my attention to it, and I find that the wheat growing upon this single patch is infected with maggot to an unprecedented extent, upwards of one-half the ears being deficient at least 50 per cent., whilst the surrounding crop is entirely free from the maggots. I find that this patch came into ear several days earlier than the surrounding red wheat, at which latter time, it is presumed, the flies were dead. The wheat that came into ear at a certain period, on about the 12th of July, is more infected than that which came into ear earlier or later than that period; and in many instances the damage is considerable, especially upon the Rough or Velvet Chaff Wheat; but although the injury has taken place, fewer maggots are in existence than I ever remember to have seen in proportion to the deficient kernels. From the Ichneumon-flies having been very active during the hot and dry weather, and in greater numbers than usual, this may be in great measure attributed, added to the dry state of atmosphere that has prevailed throughout.—*July* 4, 1846.

strument sufficiently steady, and the turnips were consequently disturbed in the rows. The tap-roots having been cut, I then pass the double plough up the centre between every six rows, and let the turnips (which pull up, the tap-root being cut, as easy as possible) to one of my labourers at 2*s*. 6*d*. an acre, at which, he finding two children, probably his own, he will make good wages, the average wages in this country being 2*s*. a day for a man. A child on each side of him hands the turnips to him, and he places them in the furrow made by the plough. One ploughing then with the common plough completes the business, by turning the earth to the turnips and covering them up to the necks: if not quite so neat as you wish, a man with a hoe will quickly and easily make it perfect. By this means I believe the plants will resist almost any frost, will be ready when wanted, cannot draw the ground, and scarcely a turnip will be rotten.

I will also mention an instrument not so much used as I think it ought to be in fallowing, particularly when land is foul—the double mould-board plough. My attention was first called to it by reading Sir John Sinclair's pamphlet on the 'Agriculture of the Netherlands,' published in 1815. He there mentions the Binot as a very useful instrument. Now the Binot is really nothing more than a double mould-board plough, and used without a coulter. The double mould-board plough elevates the land into small ridges; it does not cut the couch-grass, but brings it in lumps to the top of the ground. The ridges quickly dry, and the drag and harrows do the rest. Cultivators I have always found very apt to cut or tear the couch-grass. I have but little strong land, but on that I find it most useful: by ploughing the land for fallows before winter, the surface by the spring becomes fine and friable. Now the art is on such land, if you intend it for green crops, to keep that surface on the top. If you cross-plough this land in the spring with the common plough, you turn down that surface, and the ground turned up is as rough as ever; but plough it with the double mould-board plough when dry, and you keep the fine earth on the top, and will be able to grow Swedes or mangold-wurzel on land so strong, that with common management would be hopeless. The double mould-board plough will easily do two acres in a day.

I must also mention a use for another very valuable implement—the Presser—which I believe it is not often put to. For wheat on light land it is, I may say, universally considered invaluable. Now I have found it almost as useful for barley in the spring, when the ground, after feeding off the turnips, is often as hard as a rock, ploughs up like horses' heads, and requires eternal harrowing, and even then is in bad order: under these circumstances use the presser, which I have found work invariably well, and with half the labour to the horses.

CHARLES ALLIX.

Willoughby, Grantham, Lincolnshire, May 12.

IV.—*On Fibrous Covering.* By C. K. Vacy, M.D.

To the Secretary.

[*This paper is inserted as containing very curious and original experiments in vegetable physiology, although the experience on which it is founded is not extended enough for the immediate adoption of the principle in practice.*]

Sir,—A short time since our president, Mr. Goldsworthy Gurney, attended the Council of the Royal Agricultural Society, and communicated some practical facts resulting from experiments connected with "fibrous covering" on vegetation. The *agency*, whatever it may be, which produces this remarkable action, is at present unknown; and, until further information is obtained, we have called the supposed *principle* "*Gurneyism*," to distinguish it from the *practice;* the latter we call "*fibrous covering.*" The council expressed a wish to have more information on the subject: I believe all the information extant on this subject has originated, directly or indirectly, with our Society. The minutes of our proceedings have been taken, and the records are kept by me. Mr. Gurney has therefore requested me to communicate to you from these records in my possession and other available sources all the information I can give; as he is at this moment unable to do it, being very pressingly engaged in other pursuits.

I find that on the 7th of June, 1844, Mr. Gurney first called our attention to the singular influence of fibrous covering; and in my minutes of our proceedings of that day, it appears that (after detailing some singular atmospheric phenomena connected with vegetation which he had observed in other experiments), he said, "if a bush or other fibrous matter were left lying in a field of grass, the vegetation beneath it would soon be observed to be finer and fresher than that around it. This was a fact known to every one, and had been noticed from time immemorial; the agency by which this increase of growth was brought about, evidently involving some great and important but unknown principle, had never, in his opinion, been sufficiently investigated—indeed it had never been investigated at all. It was generally attributed to the shelter from the weather, or the protection from cattle, which the bush afforded. Men were satisfied on this supposed explanation, and no further notice, so far as he knew, had been taken of the fact. Neither of these causes had anything to do with the matter." He now detailed many experiments, showing this to be the case; and in further explanation of the phenomenon, said, "if a rod of wood, iron, or any other material, be placed horizontally above growing grass, and supported about half an inch from the top, the rod would soon be observed to produce a sensible influence on the growth beneath. A rope, or indeed a line of any sort, would produce the same effect, no matter how sheltered the situation, or how protected from cattle; two or three rods placed side by side would render the effect more sensible, and in a shorter space of time. The influence of a gate or harrow would be in the recollection of most of the members present, if left lying in a field of grass. The grass immediately beneath the framing would be seen to grow more rapidly

than that around, and become of a darker green colour—this would be found to be the case if an experiment was made either on the shady or sunny side of a wall or hedge. The more these rods or horizontal lines were multiplied, the greater would be their influence. Flags, rushes, straw, bushes, or in short any fibrous covering, would produce a similar effect. Reed, or wheaten straw, applied over grass at the rate of about a load to a load and a half per acre, would in a short time increase the quantity of grass to an incredible extent. The various grasses under it would be found to be healthy, and rapidly passing through the stages to maturity—some growing, some flowering, some seeding. The daisies, though covered, would be observed to be fully open during the days when others were open, and uniformly shut up at night: the shade would seem not to affect them in this respect, as might be supposed. Part of a field of grass placed under this operation for one month had increased in weight, upon the remaining portion left uncovered, at the rate of nearly three to one. The green grass from the part untouched, cut at the end of the month, weighed 2207 lbs. per acre, that of the portion placed under the operation weighed 5870 lbs. per acre. The grass was weighed as it came from the scythe. During this period there was not a drop of rain—and guano, nitrate of soda, lime, shell sand, wood-ashes, and other manures, possibly from the drought, tried against it, produced during this period no very visible action. In this experiment the fibrous covering was laid on the 15th of April, and the grass cut and weighed the 30th of May. Half of a lay field of 3 acres was covered on the morning of their last meeting," which was that day month, viz., the 2nd of May. "He yesterday had cut and weighed respectively those portions of the field, covered and uncovered; and found that the one weighed 3460 lbs. per acre, whilst the other weighed only 970 lbs." This field had been stocked previous to the 2nd of May, which accounted for the variation from the other field in quality and proportion; and the land was not so good. He had measured the respective lengths of grasses—"The trefoil in one case measured 3½ inches, whilst in the other it only measured about an inch; clover 6 inches, in the other 1½."

On the white Dutch the effects were more apparent, "and in the uncovered parts there was literally none, whilst on the other the ground was thickly studded, varying in height from 1 to 2 inches." The quantity of green grass produced could not be mistaken. The next question of practical interest was, whether it was watery distention or perfect elementary formation. He had exposed some of the grass cut in the first experiment to the sun for eight days, turning it occasionally. At the end of this period it was respectively and carefully weighed. "The one had lost 3914 lbs. per acre, which was about two-thirds its original weight; the other had lost 1497 lbs., which was about the same proportion." From this it would appear that the value of one was equal to the other, weight for weight, for hay—*i. e.*, a ton of the one was equal to a ton of the other: if so, in one case we should get 3 tons of hay per acre, whilst in the other only 1. He said that whilst the prodigious increase of one month's production was before us, it should be borne in mind that that month was the most productive of

the year—May and June—and that during the period, and previous to it, there had not been a drop of rain. He however observed in passing, that " he believed the dry weather had little to do with it. He had produced the same increase on some of his damp alluvial marshes on the banks of the Tamar; he had also produced it in running streams." He however wished particularly to be understood that he did not regard water and rain as the same thing. He laid particular stress on this point, for it was one in which he believed the principle was involved. Rain, in vegetation, did not act simply as water—it was not to water alone that its benefit was due. A recollection of the phenomenon he had alluded to on a former occasion showed this, if no further inquiry had subsequently been made. The action of fibrous covering had been strong during the month of March, when there was plenty of rain. It might be supposed that, by this extraordinary excitement, the ground would be exhausted. This did not appear to be the case; but supposing it to be so in the ratio of its production, the manure capable of being made from the increased quantity would fertilise the land in the same if not in greater proportion: it would be returned again to soil, and supply that which had been taken away. In other words, he said, " the *inorganic* matter of the soil would by this process be converted into *organic* matter, and when dropped by animals become a most powerful manure, by the process intended by nature for improvement and regeneration." Any person might make an experiment to satisfy himself of the peculiar action he had communicated. A bundle of straw, say 40 lbs., strewed lightly over two or three roods of growing grass, would in a very short time show the effect when raked off. It should be relaid again; after about a week or ten days, it might again be examined, and the amount of action judged of by comparing it to the other parts of the field." This communication was made in the beginning of June, and a great many experiments were immediately instituted by the members of our Society. All gave uniform results, when conducted fairly. Some used too much covering, but *generally too little*. The results of those experiments were very interesting. They showed that the action was general—that the difference in increase of growth, in a given time, was in proportion to the natural fertility of the soil. On some of the coarse moors where experiments were tried, the increase of growth was very slow as compared to better soils. It was found that the rate of action also was influenced by artificial manuring, and that the increase of vegetation was in a ratio with the natural quantity that would be produced by a given manure when laid on a field, and not assisted by the operation of any fibrous covering. A certain quantity of stall dung, which would double the quantity of grass in a given time when laid on in the usual way, was found to increase it to six times, when properly treated with fibrous covering. I made a careful analysis of the herbage produced by this action, and also that of the same ground left open. I was assisted by Mr. Gurney and other analytical chemists in these inquiries. We could find no notable difference in the proportions of organic or inorganic elements contained in the one or the other: they were the same, so far as we could discover by chemical analysis. I have since, on the continent, found the same

results had been obtained. The experiments were repeated, and we acted on large quantities. Experiments were made by some practical and scientific members of our Society on the nutritive properties of the grass, and from the hay produced by fibrous covering, comparing it with that produced naturally from the soil, and also from artificial manures. The fattening properties seem to be equal, weight for weight. They were tried on feeding cattle, milch cows, and store stock. Experiments were extensively made during the remainder of the summer and autumn.

During winter it was found the slow growth of vegetation did not pay the expense of the attention necessary to the process. Mr. Gurney, however, reported several singular facts which he had observed during the winter experiments. Snow was seen to lie longer on the surface thus operated on than it did on other parts of fields, and the soil underneath was little affected by frost. Too large a quantity of straw, when such was used, lying in locks or heaps in summer, soon killed the grass under it; but in winter it had no such effect. A piece of grass covered with too thick a layer of straw, say 3 tons to the acre, would turn yellow in a few days in summer. The same in winter would not change for months. These facts are curious, as connected with vegetable physiology. He called our attention to the peculiar analogy in the functions of animal and vegetable life. A torpid animal, in winter, might be placed under conditions with impunity, which conditions, in summer, would kill him immediately. The practical fact resulting from these winter experiments was, that long litter and waste straw from the farm-yard might be carried out and spread over the ground all the winter without any injury or expense of lifting; and that it would *not decompose* or decay, as if lying together in heaps in the farm-yard. This now is the practice; and by this plan the covering is preserved and ready to be spread for action on the first opening of spring—a covering which otherwise would have been lost. I mention this fact the more particularly because the practical objection to the working of the system is the want and scarcity of fibrous covering. Straw, which probably is the most valuable and available by this process, is preserved. All waste from the cribs and racks is thus turned to profitable account.

At our meeting, 25th April, 1845, the results of some interesting experiments, made with a view to determine the amount of the influence of Gurneyism produced by fibrous covering, when placed at certain *distances from the surface*, were communicated. I find the following record in my notes:—"He had supported the covering (long oaten straw) on light frames, elevated respectively 3 inches, 6 inches, 1 foot, 2 feet, and 3 feet above the ground. Also at the same time he had, in the same field, laid some lightly on the grass. He had noticed and measured as accurately as he could the effect produced under the covering. The experiment was made on the 26th of March, and about a land-yard of ground in each case was operated on, adjoining each other. Under the lowest covering there was soon a darker colour visible; and the white Dutch clover, the usual attendant, made its appearance in about four days; the outline of the piece was distinctly formed; the rest followed in succession. On the 17th of April the grass under the

first frame had grown through the covering; under that six inches high, the grass had increased about 5 inches in length above that of the other parts of the field, and was rapidly making its way to touch the covering; under the covering 1 foot high the grass had grown about 3½ inches; under that placed 2 feet above the ground, the grass had increased only about 1½ inch; and under that of 3 feet elevation there was simply a discoloration, marked by a definite outline: the grass was darker, looked stronger and thicker, but was not of sufficient length above that surrounding it for the difference in length to be measured. Under the straw laid on the grass it had increased about 3 to 4 inches. The most rapid growth was that under the covering placed 3 inches above the ground. Mr. Gurney, at our next meeting, communicated the result of a series of experiments made to ascertain how far *light* influenced this action. "Rods of transparent glass were used, instead of wood or reeds, in one part; and rods of wood and branches of trees in another. The same increase of growth was observed under each—under the glass and under the opaque bodies, also under some semi-opaque covering." These experiments, he said, required repetition; for there were some foreign influences which might have affected the results.

"A piece of grass land had been covered *during the day*, from six o'clock in the morning to six at night, and left *uncovered during the night*, for several weeks. Another piece lying adjoining had been *covered by night* and *uncovered by day* during the same period. The first piece—namely, that uncovered by night and covered by day—soon changed colour, put on a deep green (peculiar to the effects of Gurneyism), and rapidly increased in length; but the piece of grass covered by night and uncovered by day soon changed to a yellowish colour, and looked sickly, and apparently dying."

This fact shows that there is something connected with the influence of light, or some rays with which we are unacquainted, radiating from the sun, or some intercepted influence from the ground or other sources unknown to us, which powerfully influence vegetable life. Light has not only been generally said to be essentially necessary to vegetation, the green colour depending upon it, but the more of it the better: here, however, seems to be an experiment showing that this is not the case, and that (if it be light) the small and seemingly feeble rays reflected or dispersed from the clouds at night are sufficiently active and powerful. Possibly some radiation from the surface to the skies, of which we have no knowledge, intercepted by the physical interference of fibrous covering, may alone occasion its *modus operandi*. To those who are disposed to go into the philosophy of this subject I would observe, that in the case of the experiment of the fibrous covering being placed two feet above the growing grass, there could be no interception of the direct rays of the sun on that part lying perpendicularly below the south side of the supporting frames; yet there was no visible difference either in the colour or growth of the grass lying beneath the east, west, north, or south sides of the frames.

The practical instructions for the use of fibrous covering are few, but essential to profitable results. Straw of wheat, oats, or rushes is to be

lightly and evenly laid over growing grass, in the proportion of about a ton to a ton and a half per acre. At the end of a fortnight it must be raked up in heaps like haycocks, the grass eaten off by cattle, and the covering again relaid. This is necessary in the growing season, otherwise the herbage will grow through, by which the action will cease; the grass will also become entangled with the covering. If the land is good, the grass may be generally eaten off by cattle before the covering is again relaid: if not, at the end of the next fortnight (more or less, depending on the richness of the land, the season, and the weather), it should be done, and the covering relaid again; and repeated at about these periods through the season. This process is called "lifting." If straw be the material used, it will last through the whole summer. In the autumn it is our practice to rake it off when dry, carry it away, and stack it for winter litter. This is generally done about the time when cattle are taken in to house for the winter. The rake used for lifting should be formed with steel teeth: wood teeth, being necessarily large and blunt, do not go sufficiently near the ground, or pass easily enough between the stems of grass to remove the covering properly. Any fibres left entangled in the herbage are found to be objected to by cattle when eating off the grass. The teeth should be four or five inches long, two inches apart, and a little curved, so as to lift upwards and deliver easily when the rake is moved backwards. It is found in practice, after a little experience, that a woman will lift and relay about three-quarters of an acre per day. The rake, simple as it is, is almost necessary to good practical working; and if the Council wish it, I will send you one. Ground, under the action of fibrous covering, we find from our returns, will keep three times the quantity of cattle as ground not so treated. This experience seems in keeping with our experiments on weight and measure of the produce thus obtained.

I have kept notes of the botanical nature, development, and conditions of various natural and artificial grasses, when placed under the action of Gurneyism: they are much at your service, should you wish to have them.

Charles Kingford Vacy, M.D., Hon. Sec.

North Cornwall Experimental Club,
April 16, 1846.

THE JOURNAL OF THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

VOLUME THE SEVENTH.

PART II.

PRACTICE WITH SCIENCE.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.

THESE EXPERIMENTS, IT IS TRUE, ARE NOT EASY; STILL THEY ARE IN THE POWER OF EVERY THINKING HUSBANDMAN. HE WHO ACCOMPLISHES BUT ONE, OF HOWEVER LIMITED APPLICATION, AND TAKES CARE TO REPORT IT FAITHFULLY, ADVANCES THE SCIENCE, AND, CONSEQUENTLY, THE PRACTICE OF AGRICULTURE, AND ACQUIRES THEREBY A RIGHT TO THE GRATITUDE OF HIS FELLOWS, AND OF THOSE WHO COME AFTER. TO MAKE MANY SUCH IS BEYOND THE POWER OF MOST INDIVIDUALS, AND CANNOT BE EXPECTED. THE FIRST CARE OF ALL SOCIETIES FORMED FOR THE IMPROVEMENT OF OUR SCIENCE SHOULD BE TO PREPARE THE FORMS OF SUCH EXPERIMENTS, AND TO DISTRIBUTE THE EXECUTION OF THESE AMONG THEIR MEMBERS.

VON THAER, *Principles of Agriculture.*

London: Printed by WILLIAM CLOWES and SONS, Stamford Street.

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APPENDIX.

PLATES.

XIX.—*On the Maintenance of Fertility in new Arable Land.* By John C. Morton.

The following observations are communicated to the Society, in consequence of Mr. Pusey's request that I should state the circumstances connected with this subject, which have occurred at Whitfield farm since it has been drained and broken up out of old grass land—now nearly eight years ago. They are prefaced by some remarks on the theory of the question; for that may now be considered sufficiently well established to claim our attention before we enter on what, at the best, is but one of the cases in which theory has met with a pretty full development.

But I may, perhaps, be permitted in the first place to refer to the pressing importance of this subject; for must it not be considered to involve the great agricultural question of the day? Population increases rapidly—an imperative demand exists for an increased production of food, for an increased supply of well-paid employment—yet more than one-half of the cultivable land in this country is now yielding *grass!* The co-existence of these facts is a strange thing. Surely it is possible to grow something better, more nutritive, more remunerating than grass—something involving the profitable employment of more labour in its cultivation. If all the plants the farmer grows be arranged in the order of their value, grass must stand *lowest* in the scale: wheat, barley, oats, with their large and nutritive seeds, food for man—the turnip, carrot, parsnep, mangold-wurzel, and potato, with their large fleshy roots and tubers, food for man and for beast, must all take the precedence of grass; *its* strawy stems and narrow leaves can hardly ever be so profitable to grow—and surely *never* in those districts of this country where a dense population is but scantily supplied with either food or employment. These thoughts will occur to every one who claims any acquaintance with agriculture; and their truth, as will be shown in the sequel, is borne out by experience.

Why is it, then, that so large an extent of this country is still merely pasture land? The reason I believe to be twofold. It is to be found,

1st. In the general dislike of landowners to the growth of any other crop wherever this one has obtained an establishment; and,

2ndly. In the absence, generally speaking, of sufficient capital in the hands of the present tenants of grass lands to qualify them as cultivators of any other plant.

With the circumstances which have hindered a more extensive application of capital in agriculture, I have no concern here: the

following remarks are directed exclusively to the grounds on which the first of the above "reasons" rests :—

Landowners generally object to the conversion of grass lands; and very naturally and reasonably too, for they find that a pasture ploughed up soon loses its fertility, and becomes of less annual value per acre. Grass, by the very fact that it yields less acreable produce per annum than any other plant, and by the fact that this is generally all consumed on the land, proves itself the crop which least exhausts the soil. Any other plant, wheat for instance, or the turnip or potato, yields indeed more food per acre; but this very circumstance causes it to diminish the fertility of the soil from which it is taken. New arable land thus rapidly deteriorates in quality, and of course in value also, till ultimately it produces less food and yields less rent than the pasture out of which it was broken. But I am sure that this is no necessary consequence of growing other crops than grass, nor is this the universal experience of landowners and tenants on this subject. And I shall be very glad if a short statement of the grounds on which correct practice in this particular will be generally allowed to rest, along with the description of an experience in accordance with them, shall result in convincing any owners of pasture land farmed by intelligent tenants, that their own interest, in common with that of every other class in the nation, requires its subjection to arable culture.

The question for consideration is:—HOW CAN ANY GIVEN DEGREE OF FERTILITY IN LAND BE MAINTAINED? Professor Johnston has conclusively answered it, where he says—"Soils which are chemically and physically alike are agriculturally equal." Given, a soil whose net annual produce shall be a certain acreable sum; and you preserve its agricultural identity—its capability of annually raising similar crops, simply by taking care that its composition and its texture shall remain unaltered. This is what 'Theory' says upon the subject, and one does not see what objection can be made to a statement whose truth is so nearly self-evident. Agriculture is just to be considered as a manufacture, by which certain substances contained in the soil are converted into vegetable and animal produce; and its results, or, to use other terms, the fertility of land must therefore depend on the occurrence of those substances in abundance, and in due relative proportion. Let them be present *thus*, and let the great mass of the soil—the mixed clay and sand and lime in it—be of such a texture as permits a sufficiently free passage through it both to air and water, and the soil will be at its highest pitch of fertility. Let either its texture or its composition fail of this standard, and its productiveness will diminish. And there is no

need for imagining any mystery in this matter, as one is apt to do in cases, as in agriculture, where the unknown principle of life is concerned—this failure in the productiveness of a soil, doubtless occurs just in the same way as does that of a tile-mill or a cotton-factory, to which the raw material has been supplied in diminished quantity or of inferior quality. The fertility of the soil will be perfectly restored by replacing its texture and composition in their original condition. These are the two essential elements of its agricultural character. The *latter* is of the same obvious and immediate importance to vegetable growth that the furnishing of its food-store is to an animal; for on the composition of the soil depends the supply of nutriment to the plant. The *former* exerts an influence in several ways. On the texture of a soil depends its suitableness for the growth of different crops—light soils being adapted to one class of plants, and heavy soils to another. It is on this also there will for the most part depend *rapidity* of vegetable growth, for to it is due the *facility* with which rain-water falling on the surface of the land dissolves its soluble portions out, and carries them to the roots of the plants. And, lastly, it is to the texture of the soil that that free access of air and of rain-water to every part of it is due, to the chemical processes connected with which so much of agricultural fertility must be referred. And it is this aspect of the matter which connects it with the subject of the present paper. Dr. Daubeny pointed out, in the last number of the Journal, that independently of the small quantity of vegetable food, so to speak, available for use at any one time, an immense store resides in most soils in a dormant condition, capable of gradual development as it is required, and this process of development may by various artificial means, as by fallowing, the cultivation of fallow crops, the application of lime, &c., be greatly accelerated. It thus appears that there is hope for almost any soil—that in few cases can land be so "run out," as to require the direct supply of *all* the substances which are needed to create fertility, for many of them are already present, and it only requires a little skilful management to exhibit them. It is on the same ground that we must explain the practice, often to be seen, of allowing worn-out land to "rest" for a while, after a long period of mismanagement has exhausted its fertility. The success of this expedient, however, does not justify the practice, which is obviously most wasteful both of time and of means. The amount of "active" fertility in the soil, ought, by a judicious system of cropping and of consumption on the farm, to be made nearly to reproduce itself year by year; and the gradual development of that which lies "dormant," instead of acting as a sinking-fund to wipe out the evils of past mismanage-

ment, would then go annually to increase the fertility of the land. It is the liability of arable land to the mismanagement I speak of, which has hindered the conversion of thousands of acres of grass-land, at a time when the larger acreable produce of good arable culture is so much wanted. May we not hope that the greater capability of improvement, which is also characteristic of *cultivated* land, will, as agricultural intelligence extends, be efficient, for the future, in inducing owners of pasture lands rapidly to bring them under the plough?

The following particulars regarding the cultivation of Whitfield farm, and its results, fully bear out the views which I have quoted from Professor Johnston and Dr. Daubeny:—

It may be well first to state some circumstances in the history of this farm, which have already been published elsewhere. In 1838 it consisted of 232 acres, of which 68 were arable; the farm-buildings, then, were few and nearly in ruins; most of the land was wet and undrained; much of it was occupied by hedge-rows, its extent being divided into 63 fields, and these being surrounded by wide straggling fences containing many timber-trees; the brook which traversed the farm ran a most tortuous course, and was buried under alder, and willow, and hazel; several willow-beds, of considerable extent, occurred at intervals by its banks; portions of the eastern side of the farm were covered with coppice-wood and bramble; the soil on that side was dry; on the highest land shallow, on limestone subsoil; farther down, deeper, on sandstone; in the valley the land was very wet, containing springs of water in many places, and being liable to frequent floods from the brook; on the western side, also, it was very wet, lying on a variable subsoil, chiefly clay, though occasionally composed of alternating beds of clay and sand. Such was the condition of the land in 1838. Early in the following year the hedge-row timber was sold, realizing the enormous sum, for so small an extent, of 3300*l*. Preparations were then made for the drainage of the land, the grubbing up of the hedge-rows, the erection of farm-buildings, the making of good roads through the farm, the conversion of the grass lands, and the due cultivation of the whole. Since that time about 30 acres have been added to the farm; the plans above referred to have all been carried into effect, and the time which has elapsed is so considerable, that, as regards the policy which has been pursued, the present condition of the land may fairly be taken as determining the permanence of its results. Its results are these:—

1st. As regards the Landowner. A large and permanent, if not advancing, increase of fertility in the land. I do not here enter into any statement of the cost at which that increase of fer-

tility has been obtained: the high price of draining-tiles, the exceedingly rough condition in which the land lay, the unpropitious nature of the season during which most of the operations were conducted, united to swell the expense of the improvements at Whitfield. They might have been perhaps now effected for a less expenditure; but with all this our subject has nothing in common: it is with the *permanence* of the result, not with its *cost*, that we have to do. On the latter point an overwhelming amount of evidence exists that the cost of agricultural improvement is not such as to make it *unprofitable*.

2ndly. As regards the Farmer. Of course, in the general, it is true that land lets for its full value, whatever that may be, and however obtained; but there can be no doubt that the results of draining, erection of farm-buildings, and other improvements, such as those carried on at Whitfield, are beneficial to the tenant, as permitting a profitable concentration of his capital, thus bringing the application of it more closely under his superintendence.

And, 3rdly. As regards the Labourer. The effect at Whitfield has been an increase in the amount of yearly wages paid, from about fifteen to upwards of fifty shillings per acre.

And I may add, 4thly, As regards the national interests, which are eminently concerned in any scheme for an increased supply of food, that the annual produce of this farm has increased, since 1838, from a value of 500*l.* in cheese, butter, young stock, and a little wheat, barley, and potatoes, to one of about 1800*l.* in wheat, fat sheep, cattle, and pigs.

All these circumstances are stated simply as facts—no boast is either made or intended—similar results have doubtless been obtained elsewhere: and the inference to be drawn from all (a legitimate one, if I can show that these are now *permanent* characteristics of the land thus altered) is, that it is decidedly for the interest of *landowners* to take immediate steps for the proper *cultivation* of their grass lands: that, if this were done, *farmers* would be benefited—*labourers* would be greatly benefited—and that for *all* a permanently increased production of food would be obtained.

It may now be advisable to enter into some detail in illustration of the increased fertility which is asserted to exist on this farm. The following table exhibits the value of some of its fields ten years ago, when the whole of the parish was valued, and their valuation now, after having been seven or eight years in cultivation:—

Number of Field on Old Plan.		Gross Acreable Value, 1836.	No. of Field on New Plan.	Gross Acreable Value, 1846.	Difference.
		s. *d.*		*s.* *d.*	*s.* *d.*
92	Pasture .	13 0	8	50 0	35 0
84	Ditto .	17 0			
59	Ditto .	27 0	2	50 0	23 0
89	Ditto .	11 0	16	34 0	21 6
91	Ditto .	12 0			
67, 71, 72	Ditto .	17 0	1	52 0	35 0
75	Ditto .	20 0	6	50 0	30 0
105, 106	Ditto .	11 0	24	32 0	21 0
85, 86	Ditto .	13 0	7	47 0	34 0
*143, 144, 152	Arable .	36 0	12	44 0	8 0
*153	Ditto .	34 0	13	44 0	10 0

In justification of these items, I may give the history of one or two of the fields here enumerated. No. 8 was one of the poorest fields on the farm: it was drained in 1840, and its surface was pared and burned in the autumn of the same year; it was ploughed into perch-wide ridges, without reference to the position of the drains, and it lay so till the spring of 1841, when it was sown with oats, of which it yielded a large crop—upwards of 8 quarters per acre; the stubble was ploughed, and in the spring of 1842 it was manured and grubbed, or "cultivated," and sown with mangold-wurzel, and it yielded an enormous produce of that root, certainly much above 30 tons per acre; in 1843 it was sown with wheat, and yielded upwards of 46 bushels per acre; in 1844 it was planted with potatoes, but these partly failed owing to the dry-rot; in 1845 it bore wheat again, and there never was a finer promise of a crop than was exhibited on that field in the month of June, but the weather of July laid it, and its produce was greatly injured both in quantity and quality. Clover seeds and Italian rye-grass were sown among the young wheat in the spring of 1845, and several very heavy crops of rye-grass have been cut off the land during the past year. I do not think that the rental of this field is put too high at 50*s.* per acre.

Now, take No. 2, a field originally of much better quality than No. 8. It was pared and burned in the spring of 1840—ploughed, harrowed, and sown to common turnips, of which it yielded a fair crop; in 1841 it bore oats—a crop of about 10 quarters per acre; in 1842 it was sown with the white Belgian carrot, and it yielded 22 tons per acre of them; in 1843 it yielded 42 bushels of wheat; in 1844 it yielded a crop of swedes—not very good, owing to the character of the season; in 1845 the promising plant of wheat which covered it was laid and much injured by the rough weather

* These grounds were naturally dry, and had the character of being "the best potato land in the parish."

during August in that year; during the past year large crops of Italian rye-grass have been cut off it.

I need not further describe the fields which have been selected. I believe they are pretty fairly valued. The immense increase which they exhibit in the annual value of some parts of the farm is to be attributed doubtless in great measure to the thorough-drainage which it has received, to the buildings which have been erected on it, and to the roads which have been made through it; but also, and chiefly, to the conversion of its pastures, which have given profitable opportunity for the application of capital and skill. And does not the circumstance that the facts given are those of a history extending through a period of at least seven years, prove that they may be considered as *permanently* characteristic of the land to which they refer?—that is, so long as the present system of cultivation shall continue to be adopted.

So far from the land giving any sign of exhaustion, I do not hesitate to say that, during the past few years, it has been increasing in richness. Its great fault now is its tendency to grow too *much* straw, which being converted into manure for re-application to the land, has been year by year adding to the mischief; till now, by permission of the Earl of Ducie, our landlord, we have endeavoured to meet the growing evil by altering our system in part—seeding our rye-grass occasionally, and taking a crop of beans in place of a green crop; and it is hoped, by thus robbing the land of some of its fertilizing elements, to diminish that tendency to grow so much straw, by which our wheat crop has latterly been so much laid.

But I must now describe the method of cultivation by which this permanence in the fertility of broken-up grass-land has been secured. The principal feature in the system, and of course I do not describe it as any thing new, is the alternation of grain crops for *sale* with green crops for *consumption*.

After the drainage of the land, half of it was ploughed up before winter, and, half, pared and burnt early in spring: the former portion was sown, most of it, with oats; the latter was prepared for turnips. The elements of fertility naturally present in the soil ensured the abundance of the first crops, and thus sufficed, free of expense, to start that system of alternate husbandry in full vigour, which more than any other that can be named has the merit of self-maintenance. Every other year, for a longer or shorter period since, every field on the farm has borne a crop of wheat, and on the alternate years the crops have been successively clover, turnips, carrots, clover, mangold-wurzel, potatoes. The root crops have been for the most part carried to the buildings, and there consumed with and on the straw, by cattle, sheep, and pigs. The dung thus manufactured is either carried out, as it is

made, to the fields on which during the ensuing year it will be used, or to stations near the liquid manure tanks, where it may be properly manufactured. About three thousand cubic yards are thus annually applied to the green crops. It is not only made from the consumption of roots and straw, but large quantities of oil-cake, oats, linseed, and beans are also consumed, and these no doubt add much to its richness. The annual application of so much fertilising matter ensures heavy crops of roots and straw—it ensures *that*, on which the farmer depends for the re-application each year of an equal quantity of manure. The system thus maintains itself: it was set a going without much expense, and it contains within it the elements of a permanent establishment.

No doubt in this, as in every other system of cultivation I have heard of, the soil suffers an annual abstraction of its substance; but this is not necessarily inconsistent with the maintenance of fertility. Dr. Daubeny has shown us that the soil contains, so to speak, an exhaustless store of fertilising matter, and all that is needed to make this abundance apparent as well as real, is so to expose the soil, as that for every abstraction by the growth of a crop, a transfer of equal amount may be made by the solvent powers of atmospheric agents from the *dormant* stores within it, to those which are immediately available for the use of plants. It is upon an abundance of the latter description that the current fertility of a soil depends, and this may be maintained in spite of the continued robbery occasioned by selling crops, provided the balance be made good. Now the efficiency of the system of cultivation adopted at Whitfield, in maintaining fertility notwithstanding heavy sales of farm produce, may be accounted for in great measure by the frequency of fallow crops, whose cultivation is attended by such constant and repeated stirrings of the soil, that rain-water will have peculiar facilities for acting as a solvent upon its substance. In addition to this there must be considered, the purchase and consumption of considerable quantities of cattle-food, and the preservation of the manure made from it.

These are the three points to which we must look for the maintenance of arable farming. As regards the second, I may just state how far the matters annually brought on to this farm go to balance the loss it sustains of the matters annually carried off it. The account stands thus:—There is an annual abstraction from the soil of about 500 quarters of wheat—the produce of 120 acres of land; and of an amount of beef and mutton equal to the increase during five months on 30 to 40 three-year-old oxen, and during eight months on 250 to 300 shearling sheep, as well as of the substance of some 20 or 30 bacon hogs, bred and fattened on the farm; in addition to this, there has lately been an annual sale of about 50 tons of Belgian carrots, and about 40 tons of

potatoes. The mineral portion of all this matter is annually taken out of the soil. In the sales of vegetable produce alone, it thus sustains an annual loss of about 4 tons of its most valuable portion. But this is partly compensated by the purchased cattle-food which is consumed upon it:—About 200 quarters of oats, 10 to 20 tons of oil-cake, and 40 to 50 quarters of linseed, barley, and beans are thus consumed. The weight of their mineral constituents may be about 35 cwt. This reduces the amount of robbery committed, to $2\frac{1}{4}$ tons; and we must suppose that the land is annually suffering an abstraction of this quantity of its best part, not to speak of the mineral portion of about 40 tons of butcher's meat also taken out of it. And all this, and more—for the land, so far from suffering from the treatment it receives, is exhibiting every year greater ability to grow the heavy and bulky crops it has hitherto yielded—all this and more must be manufactured and prepared as vegetable food, by the agency of the air and rain, out of the very substance of the land.

"But this obviously cannot last for ever—the land must ultimately be exhausted:"—So *he* will say who has not duly considered the origin of the soil and the means by which it is maintained. The mineral part of the soil is obviously the result of the disintegration of rock; and in the subsoil below it an endless store of similar matters exists. We may see here the great advantage of any system by which the rain-water shall be enabled and induced to sink *through* the land down to the subsoil below it, *there* to effect the solution of those substances occurring there, which in their present state are useless to plants. And probably one great cause of the barrenness of undrained land is to be found in the circumstance that its crops, after using up the limited stores of food which it contains, are afterwards dependent upon the very small portion which the rain-water, under the unfavourable circumstances in which it is there placed, can provide for them. Undrained lands send the water off their surface; they do not permit it to penetrate, and thus it has no chance of performing that which may be called its appointed office—no chance of preparing from the substance of the soil a sufficient supply of nutriment for the plants growing on it.

The third point referred to above is also a most important one in the general scheme of permanent arable culture. It will be seen that, as it is, under our plan of cultivation (and the same will be found to a greater or less extent under every other plan in operation), a large draught is annually made upon the substance of the soil, in order to maintain its fertility; and it is not desirable unnecessarily to increase this call by carelessness in using the means we have of supplying the wants of the crops. The management of manure is obviously a most important branch

of the farmer's business, and one to which a great deal of attention has of late years been directed.

Nevertheless, on a farm of any extent, my experience, so far as it goes, is entirely opposed to the alleged economy attending the use of the liquid-manure cart, which has been so extensively advocated. It is no doubt of the greatest importance that the urine of the animals fed on the farm be all saved; but this advantage is *dearly* bought by the labour which attends its *direct* application on distant fields. I believe that the cheapest and best method of consuming cattle-food, both as regards the manufacture of butchers' meat and the manufacture of manure, is Mr. Warnes' system of box-feeding. In it the straw used as litter accumulates under the cattle for many weeks together, the urine is entirely absorbed, and no water falls on the mass to wash out any of its soluble parts. This is the plan adopted here. The boxes are cleaned out when they become inconveniently full, which may be at intervals of twelve to fourteen weeks, and the manure, which is of the richest quality, is then at once taken to the field where it is to be used, laid upon a bed of earth, and thickly covered with the same. The manure from the sheep is prepared in the same way: it is removed, perhaps twice in the winter, from the sheds under which it accumulates. That, however, which is made in the stable is of course daily carried out to a heap hard by, and the urine of the horses is collected in a tank near the place, and from this it is pumped, to soak the half-wetted straw.

It must be acknowledged, that here, as on every other farm that I have seen, there are many causes of waste in operation. The rain, as well as the liquid manure, falls upon the dung-heaps, and if the latter enriches, the former impoverishes the mass, which is alternately saturated by them. Large open yards, too, necessarily receive an immense quantity of rain-water in the course of the winter. Upwards of 27,000 cubic feet annually fall during that season on ours; a quantity and weight which it is impossible, with profit, either to collect in tanks or to carry to the fields. A large portion of this water *must* therefore run to waste, and it carries with it the soluble part of whatever manure it washes. We endeavour to prevent this as much as possible; and in consequence of our system of box and shed-feeding, we doubtless sustain less loss in this way than many other farmers; but a certain injury is no doubt suffered—one, however, which we think cannot be remedied by any application of the cumbrous machinery of water-carts and tanks.

It is to these three departments of farm-management, then, that we must look to keep up the fertility of land under arable culture: the alternate system of husbandry, by which the land

receives almost every other year a thorough fallowing and cultivation; the consumption of large quantities of cattle-food, by which the loss sustained by the soil in consequence of sales of farm-produce is in great measure balanced; and the careful preservation of the manure that is made. Let the pitch of fertility be what it may, and whatever its cause, I have no doubt that attention to these particulars will preserve it. It may be owing to the natural character of the soil—it may be due to the skill of a former tenant—or it may be the extraordinary effect of *rotting or burning an old sward*—of bringing old pasture into cultivation. However it has arisen, there can be no doubt that ordinary energy will maintain it, if attention be paid to the points above alluded to.

No reference has been made to the use of artificial manures, as they are called. I believe that they are rarely necessary to the maintenance of fertility; no doubt they may often be advantageously used to *increase* fertility, but that is hardly ever desirable in the case of newly broken-up land; good crops may generally be obtained in such a case without much assistance, and that they may continue to be so obtained I am very sure. Will not the experience at Whitfield Farm which I have described, be admitted as proof of this? Some of the land is a deep gritty sand; much of it a stiff clay soil; in many places a peaty loam; on some fields we have a shallow limestone soil on rock; on others a deep vegetable mould resting on magnesian clay and stone;—on *all*, when grass-land after drainage has been broken up, the scanty produce of cheese and butter, characteristic of its former condition, has been exchanged for bulky crops of roots and grain, a large produce of food for man and for beast: and on *all*, without the use of bought manure of any kind, these crops, so far from diminishing as years pass by, rather exhibit an increasing fertility in the land which yields them. Is there not variety enough of soil, and uniformity enough of result here, to justify general confidence? The fact is, that our crops of straw have latterly been so bulky as seriously to interfere with the produce of grain; the wheat has been laid and its yield injured in consequence of the luxuriance of its growth. This has been a growing evil, but it is certainly no sign of a diminishing fertility.

Now, I am perfectly aware of the extreme changeableness of farm experience, arising doubtless from the many uncontrollable and variable causes on which that depends: but it is impossible to disregard the *uniform* evidence of an experience extending over eight years; and I certainly think that the results of farm practice at Whitfield may well convince any landowner that the breaking up of his grass-lands, if profitable to him the first year, may easily be made so during every succeeding year of their culti-

vation, whether he grows wheat only, as we do, or introduces other grain crops.

I do hope that the facts stated and the arguments urged above, may add in some measure to the influence which has been doubtless exerted by Mr. Bravender's admirable essay on a similar subject, in the last number of the Journal. It is certainly of great importance, especially for the labourer, that means be taken to induce the thorough *cultivation* of lands which now yield so little food and so little employment.

Whitfield Farm, near Wotton Underedge,
Dec. 2.

XX.—*Experiments on the Feeding Qualities of different Breeds of Sheep on the Earl of Radnor's Farm at Coleshill.* By E. W. Moore.

To Mr. Pusey.

Sir,—I deferred sending you the particulars of the experiments made here on the feeding of sheep, as I had hoped to have continued them through another season; but, as I did not succeed in doing so, I now beg to forward them. I believe the tables will be sufficiently explanatory; but it is proper that I should observe, that during the progress of the first experiment two of the Leicesters were ill, and never recovered. (It was found after they were slaughtered that their livers were diseased.) I may also state that the different kinds of sheep were selected from the undermentioned flocks,* and each party was present at the various times at which the sheep were weighed. I have lately seen the account of an experiment between some half-bred sheep and the Leicesters, which confirms the opinion I entertain, that up to a certain point there is no breed of sheep that will make mutton so rapidly as the Leicester in proportion to the food consumed. I should be very pleased to see the result of further experiments of this character, although it cannot be questioned that the value of the different breeds very much depends upon the circumstances and situation in which they may be placed.

I am, Sir, your very obedient servant,
E. W. Moore.

Coleshill, 25*th Nov.* 1846.

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* The Leicesters from the Earl of Radnor's; the Southdowns from Mr. W. H. Rickards, Maggot Mill Farm; the half-breds from Mr. G. Dyke's, Coleshill; the Cotswolds from Mr. Newman, Coleshill.

(1844.—5 Sheep in a Lot.)

EXPERIMENT No. 1.

Description of Sheep.	Date when put up.	Weight of each Lot of 5 Sheep.	First Month. Description and Quantity of Food consumed. Hay.	Pulse.	Turnips.	Weight of each Lot at the end of First Month.	Increase on each Lot.	Second Month. Description and Quantity of Food consumed. Hay.	Pulse.	Swedes.	Weight of each Lot at the end of Second Month.	Increase on each Lot.	Third Month. Description and Quantity of Food consumed. Hay.	Pulse.	Swedes.	Weight of each Lot at the end of Third Month.	Increase on each Lot.
			lbs.	Pints.	lbs.			lbs.	Pints.	lbs.			lbs.	Pints.	lbs.		
Leicesters......	1844. Jan. 23.	265 lbs. or 53 lbs. each.	68	123	1398	300 lbs. or 60 lbs. each.	35 lbs. or 7 lbs. each.	70	155	1862	320 lbs. or 64 lbs. each.	20 lbs. or 4 lbs. each.	61	130	1876	350 lbs. or 70 lbs. each.	30 lbs. or 6 lbs. each.
South Downs ..	Ditto	220 lbs. or 44 lbs. each.	68	139	1578	250 lbs. or 50 lbs. each.	30 lbs. or 6 lbs. each.	75	155	2272	280 lbs. or 56 lbs. each.	30 lbs. or 6 lbs. each.	66	130	2348	320 lbs. or 64 lbs. each.	40 lbs. or 8 lbs. each.
Half-breds. Cotswold and Southdown...	Ditto	340 lbs. or 68 lbs. each.	70	164	1719	370 lbs. or 74 lbs. each.	30 lbs. or 6 lbs. each.	81	155	2546	400 lbs. or 80 lbs. each.	30 lbs. or 6 lbs. each.	68	130	2485	440 lbs. or 88 lbs. each.	40 lbs. or 8 lbs. each.
Cotswolds......	Ditto	345 lbs. or 69 lbs. each.	70	15	1744	380 lbs. or 76 lbs. each.	35 lbs. or 7 lbs. each.	87	155	2759	420 lbs. or 84 lbs. each.	40 lbs. or 8 lbs. each.	68	130	2706	460 lbs. or 92 lbs. each.	40 lbs. or 8 lbs. each.

Remarks.—Calculating Hay at 50*s.* per ton, Pulse at 19*s.* per sack, Swedes at 10*s.* per ton, and Mutton at 6½*d.* per lb., places the Lots in the following order:—1st, Cotswolds; 2nd, Downs; 3rd, Leicesters; 4th, Half-breds: the difference being very slight. It should be added, that the Cotswolds were very fresh when put up, the Half-breds in good condition, and the others poor.

Description of Sheep.	Total Quantity of Food consumed. Hay.	Pulse.	Swedes.	Total Increase of Weight.
	lbs.	Pints.	lbs.	
Leicesters..............	199	408	5136	85 lbs. or 17 lbs. each Sheep.
South Downs..........	209	424	6198	100 lbs. or 20 lbs. ,,
Half-breds............	214	449	6750	100 lbs. or 20 lbs. ,,
Cotswolds............	225	438	7209	115 lbs. or 23 lbs. ,,

N.B.—The increase of weight in Mutton is calculated as follows:—The live weight is ascertained and divided by 7, which gives the weight per quarter; this multiplied by 4 gives the weight of the carcase. Whether correct or otherwise, it answers the purpose for experiments of this kind.

(1844-5.—3 Sheep in a Lot.) EXPERIMENT No. 2.

Description of Sheep.	Date when first weighed and put together.	Weight of each Lot, Aug. 29, 1844.	Weight of each Lot when put up to Feed, Jan. 4, 1845.	Increase in Weight whilst grazing, during 4 Months.	Kind and Quantities of Food consumed, from Jan. 4 to March 31, 1845.		Weight of each Lot, March 31, 1845.	Increase on each Lot, from Jan. 4 to March 31, 1845.	Total Increase of Weight, from Aug. 29, 1844, to March 31, 1845.	REMARKS.
					Hay.	Swedes.				
Leicesters....	1844. Aug. 29.	138 lbs. or 46 lbs. each.	169½ lbs. or 56½ lbs. each.	31½ lbs. or 10½ lbs. each.	lbs. 255	lbs. 4027	216 lbs. or 72 lbs. each.	46½ lbs. or 15½ lbs. each.	78 lbs. or 26 lbs. each.	There being no account of the quantity of food consumed whilst the Lambs were grazing, of course no comparative results are ascertained for that period. During the time they were housed (calculating the Hay at 70*s.* per ton, Swedes at 10*s.* per ton, and Mutton at 7*d.* per lb.) it will be seen the result of this experiment is in favour of the Leicesters; 2ndly, Half-breds; 3rdly, South Downs; and against the Cotswolds.
South Downs..	Ditto	141 lbs. or 47 lbs. each.	174 lbs. or 58 lbs. each.	33 lbs. or 11 lbs. each.	252	4110	216 lbs. or 72 lbs. each.	42 lbs. or 14 lbs. each.	75 lbs. or 25 lbs. each.	
Half-breds....	Ditto	133½ lbs. or 44½ lbs. each.	169½ lbs. or 56½ lbs. each.	48 lbs. or 12 lbs. each.	261	4255	222 lbs. or 74 lbs. each.	52½ lbs. or 17½ lbs. each.	88½ lbs. or 29½ lbs. each.	
Cotswolds....	Ditto	169½ lbs. or 56½ lbs. each.	201 lbs. or 67 lbs. each.	31½ lbs. or 10½ lbs. each.	276	4862	252 lbs. or 84 lbs. each.	51 lbs. or 17 lbs. each.	82½ lbs. or 27½ lbs. each.	

N.B. The Lambs were all put together on the 29th of August, and grazed until the 4th day of the following January. Each party kept the whole on his farm for a month.

XXI.—*Experiments made upon the Growing of Turnips with different Manures, on the Farm of Gordon Castle, in the year* 1845.

From his Grace the Duke of Richmond.

The soil is a light sandy loam, and the lots, consisting of one imperial acre, were sown with Dale's hybrid turnips on the 12th of June; they were taken up on the 25th of December, and after the roots and shaws were carefully taken off, the weight of the bulbs with the different manures were as under.

Lot.		Cost per Acre. £.	s.	d.	Weight per Acre. Tons.	Cwt.
1	Manured with 14 yards farm-yard manure and 8 bushels of bones	3	6	0	12	$18\frac{3}{4}$
2	14 yards farm-yard manure and $1\frac{1}{2}$ cwt. African guano	2	12	3	12	$18\frac{3}{4}$
3	14 yards farm-yard manure and 2 bushels bones dissolved amongst 50 lbs. sulphuric acid, mixed with 25 bushels coal ashes, and sown with hand	2	10	4	12	3
4	4 bushels bones dissolved amongst 100 lbs. sulphuric acid, mixed with 25 bushels coal ashes, sown with the hand . . .	1	6	7	10	$18\frac{1}{4}$
5	16 bushels bones	2	8	0	8	11
6	3 cwt. African guano	1	2	6	10	$13\frac{3}{4}$
7	14 yards farm-yard manure and 14 cwt. Cornwall patent manure	4	5	9	6	6
8	26 cwt. Cornwall patent manure . . .	4	1	3	2	14

At the same time I beg to state, that where I applied artificial manures to the land for turnips in former experiments, the following or succeeding crops were not nearly so good as those after farm-yard manure.

(Signed) Thomas Bell.

Gordon Castle, 25th December, 1845.

XXII.—*On Burning Clay.* By J. J. Mechi.

To Mr. Pusey.

Dear Sir,—I have great pleasure in communicating what I know of the benefits of burned earth as a manure. I have used it for wheat and for root crops with decided advantage, although I have not, unfortunately, kept a statistical account of the difference; still so obvious were the results that I have been induced

to use a much larger quantity the present season, and my neighbours are following my example. It was used at the rate of 1000 bushels per acre on a wheat-field sown with clover, leaving the middle of the field undone. The benefit was striking, not only in the wheat, but in the young clover. The whole of the field had been top-manured with guano, harrowed in with the seed. Where the burned earth was not used, the clover-plants and the wheat were inferior.

It may be proper to explain that it was not turfy earth full of vegetable matter, but a poor, cold, argillaceous, tenacious clay, such as is used for making bricks, yellow in colour, but becoming when burned a pale red or orange: the interior of some of the largest lumps being black or carbonaceous (I presume the small quantity of vegetable matter concentrates there); occasionally this soil contains a fair proportion of round pebbles.

The mode of raising and burning is this—a strip of land is broken up in *very dry* weather with Ransome's Y. L. plough, drawn by three strong horses abreast, and a Scotch equilibrium whippletree. So great is the resistançe that it requires two men to hold the handles of the plough to counteract the leverage of the horses. The earth is thus broken, or I may say torn up in immense rough masses or clods as much as a man can carry, which are admirably adapted to form walls and supports for the mass of fire. By this means heaps of nearly 200 solid yards may be readily burned. The earth being ploughed up, the fires are formed on the spot, the workmen placing a certain quantity of dried stumps or wood of sufficient solidity to maintain a body of heat, and enclosing the mass with large clods. These are carried by hand: subsequently, as they get more distant from the fire, a barrow is used, and beyond that a one-horse cart.

It is important to have the sides of the heap as upright as possible—not conical—because the heat always makes for the highest place. An important point in burning is to supply the fire sufficiently fast to prevent its burning through, and yet avoid overlaying it, which might exclude all air, and put it out. Practice will indicate the medium. When the fire shows a tendency to break through, the outside of the burning mass is raked down, and more earth added.

If the ground is very dry, and no rain falls, the men are obliged to feed the fire almost continually night and day; but when there is moisture, it may be left for five or six hours, but seldom longer.

Something depends on the current of air. A strong wind would blow the fire *from* one side and out at the other. This is guarded against by placing hurdles interlaced with straw as a guard to windward.

The size of a heap is limited by the height to which a man can throw up the soil, and of course the diameter must be proportioned to the height, to prevent its slipping down. It is generally lighted so as to burn out by Saturday, and not require Sunday attendance.

This mode of burning may be essentially called summer burning, because we find practically that heavy rains put out the fires, or check their progress. Where fuel is abundant, or coal cheap, I have reason to believe fires may be kept up through the winter.

I have this autumn ploughed up or rather broken up and burned 4 acres of a poor rye-grass lea. This has produced 1600 cubic yards, 1000 of which I have carted on to the neighbouring fields, leaving 150 yards per acre on the field itself as a compensation. The cost per 100 cubic yards is as follows:—

Labour and burning at 5*d*. . . .	£2	3	4
Fire-wood at 4*s*. 6*d*. per fathom . .	0	8	4
Ploughing and horse-labour . . .	0	8	4

Carting and spreading according to distance.

When spread, as there are many large lumps, we roll the field with Crosskill's clod-crusher in a dry time. This pulverizes the burned earth, and we then bush-harrow to distribute it equally. Our young clover so treated promises well.

As the portion of ground on which the fire is made is generally burned 6 inches below the surface, it is proper to dig it out and spread it around, otherwise so rank will be the corn-crop there, that in spite of two or three flaggings, it is almost sure to go down and spoil. I find burned earth exceedingly useful for clamping potatoes, swedes, mangold, &c.; but it is essential to allow roots to remain in a heap covered with straw three or four weeks previous to doing this, or they are apt to heat and rot, especially early raised potatoes. The reasons why earth burned must be beneficial are sufficiently explained by Drs. Liebig and Playfair.

Of its cheapness as a manure there can be no question, for whilst it only costs 7*d*. a cubic yard on the spot, the mere cartage of London dung from our nearest port would be 2*s*. per cubic yard, nearly 4 times the cost of the earth itself.

It is much to be wished that tenants had permission to put down all old pollard-trees, burning them on the spot with earth close at hand. Such pollards when carted home seldom clear 1*s*. each, after deducting expenses, whilst it is to be feared they damage the growing crops annually to that extent at least.

Yours truly,

Tiptree Hall, Oct. 10*th*, 1846. J. J. Mechi.

I should say that at 5*d*. per yard my men average (including occasional night-work) about 15*s*. or 16*s*. per week in dry weather.

XXIII.—*On the Nature and Cause of the Potato Disease.* By George Phillips.

Prize Essay.

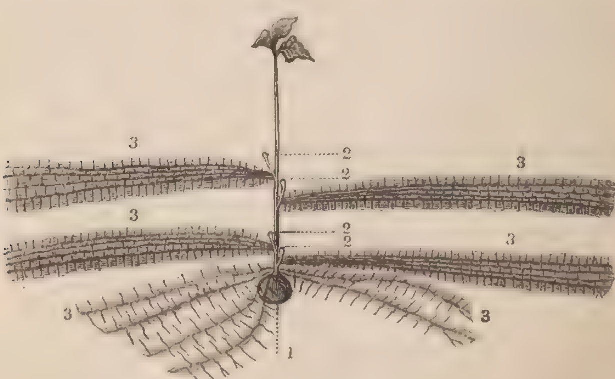
Before any conclusion can be arrived at as to the nature and cause of the disease, various subjects have to be considered; and as these are different in character, I propose to consider them under separate heads, and, having done so, to conclude with the nature and cause of the disease itself.

1. *The Plant.—Its roots.*

The outward character of the potato plant offers nothing very striking to the eye of a casual observer. Leaves, stem, and roots present themselves, and we see in them only the natural order that appears more or less in every vegetable organism. In this respect, indeed, all vegetables are alike, for stems, roots, leaves, or something analogous, appear even in the lowest class of plants, the fungi. These minute forms, some of which cannot be seen by the naked eye, are nevertheless as regularly organized as the potato: and like that too, some of them produce their own kind by seed as well. We cannot therefore by a glance perceive that the potato possesses anything uncommon in its character, for we see only the ordinary appendages of vegetables, and we see nothing beyond. And yet this plant has an arrangement of parts which, if closely examined, cannot fail to strike our minds with its fitness for certain conditions; and we may read in those organs, as in a book, that which teaches us what the plant demands in its culture if its powers are to be healthily employed.

Plate 3 represents a young plant growing from the set; the stolons or strings (2) are forming; the roots (3) are somewhat

Plate 3.



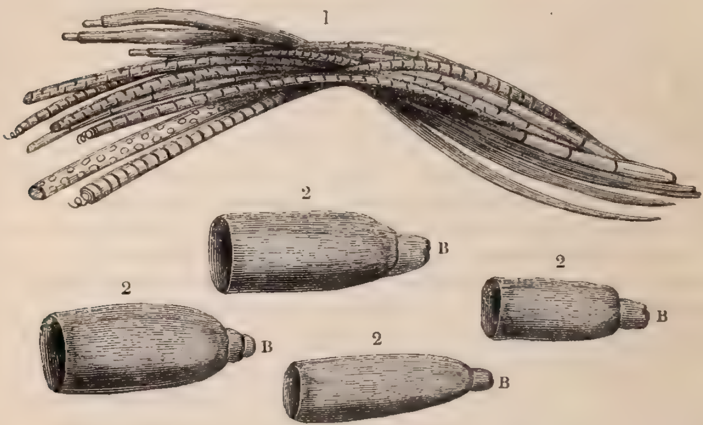
Young plant growing from the set.
1. The set. 2. Pendulums or stolons. 3. Roots.

advanced, and the plant has arrived at a state in which it could exist if the parent set were taken from it.

The stolons spring alternately from the footstalk, and in opposite directions to each other, and at their commencement grow upwards for a few inches, generally at an angle of from 18° to 20° with the stem. Each stolon has 4 main roots, see plate 3, fig. 3; these roots accompany the stolon and spread themselves out horizontally and at right angles with the footstalk. Two of the main roots spring from the base of the stolon at its juncture with the stem, and two at the superior part where the lines meet that from the apex of the angle. The main roots have numerous lateral ones, which again have their laterals. Each fibre is terminated by a spongiole, or mouth for absorbing water and inorganic matter from the soil. In a young plant, such as plate 3 represents, I carefully measured and counted the roots in order to ascertain the number of absorbents and the length of the roots as well. The plant thus examined was a mere germ, and not advanced beyond what the plate represents. It had 6 stolons and 24 main roots. The length of these roots varied from 9 to 12 inches, giving rather more than 10 inches as the mean length of each root. The lateral roots springing from the main roots varied from 1 to 3 inches in length, and averaged 10 to every inch of the main roots. Taking the mean length of the laterals at 2 inches and their number at 10, we have 4800 inches, or 400 feet for the length of roots in a young plant barely more than a germ. To the roots of this plant there would be 2424 distinct mouths or absorbents for feeding the plant, a number apparently great, considering its size. But great as this extent of roots and number of spongioles in the young plant may appear, it is only a fraction of what exists in a full-grown one. In a healthy plant of the shaw kind in a state of maturity there is at least 10 sets of main roots with 4 to each set. The length of the main fibres average 12 inches each, the laterals 10 to every inch, with a mean length of 4 inches for every lateral. Assuming these data correct, we have 19,200 inches, or nearly one-third of a mile for the length of the roots of a potato plant when at maturity. The number of mouths or absorbents to this extent of roots is very considerable; for the main roots and all the laterals terminate in spongiole, and as new filaments appear, so do absorbents also appear with them; consequently the length of roots and number of mouths are increasing with the growth of the plant until nature has exhausted her powers by a completion of the products the plant was destined to form. Calculating, therefore, at a low average, the number of mouths in each lateral of 3 inches' length at 5, and taking the number and extent of the roots as already shown, we have 24,000 absorbents for the whole plant, which, while in health, are

actively employed in seeking water and inorganic matter from the soil for its sustenance. Great as this number of absorbents may appear, it will be found by examination to be underrated, for all parts of the roots abound with them. They are so minute that many of them cannot be discerned by the unassisted eye, and their web-like filaments are easily broken. Plate 5, fig, 2, B represents the absorbents as they appear when greatly magnified.

PLATE 5.



1. Vessels of the gem. 2. Spongioles of roots.
Power of object-glass used, 360 diameters.

The internal arrangement of the roots is simple; there is an epidermis and a porous mass of tubes without diaphragms; the sponges or absorbents are simply the porous tubes without the epidermis, and they are probably no more than a prolongation of the roots caused by a more rapid growth of the tubes than the epidermis. This view seems correct from the circumstance of their enlargement and extension, as they grow and advance with the growth of the roots. The great absorbent power of the roots of the potato plant shows its fitness for a dry situation, and therefore accords with what is needed for its products, the tubers.

2. *The Growth and Construction of the Stem.*

Plate 6 represents a longitudinal section of a stem attached to the set from which it sprung. 1 and 2 are stolons, E, the crown of the set; B, the channel that contains the germ; A, a diseased part of the old tuber or set; C, the cellular structure of the set; and D, the lower part or termination of the vessels of the germ from which the plant sprung. The vessels that form a germ are always in a bundle in the tuber, and situated just beneath the eye,

to which they belong. They represent a cone, the base being in the tuber and the apex at the eye. As germination proceeds, the whole of the vessels elongate themselves, and the bud or eye advances through the epidermis, and appears externally on the tuber. A longitudinal section therefore shows what appears two or more sets of vessels, a consequence arising from their circular arrangement around the cellular tissue of the medulla. Although for convenience the vessels are represented in the plate as passing by the stolons without diverging so as to communicate with them, this is not so in the plant; for the medulla and all the vessels except the spirals throw off branches, that lengthen and become the vessels of the stolons themselves; and thus a communication from the medulla itself exists with the stolons. When the vitality of a germ is brought into action, the starch granules flow, apparently unchanged, up the medulla of the stem from the channel B, in the old set, and nourish the young plant. These starch granules may be traced from the old set through the medulla and vascular system of the stem into the stolons, and the flow continues from the set until leaves are formed by the young plant. When the plant has thrown out leaves, the starch granules from the set cease to flow, and can no longer be traced in the stem from the set. The lowermost stolon, 1 A, is formed before 2 A: but 2 A will have tubers formed before 1 A shows any appearance of them. The formation of the stolons and tubers is therefore inverted, and seems to be governed by proximity of source supplied from; but whether this peculiarity in the mode of secretion be the consequence of electrical action, or whether it be due to exosmose and endosmose, gravitation, or any other thing, we have no evidence to show. The crimson spots, A, and the vessels traversing the cuticle of the stem into the stolon, 2 A, plate 6, show the situation of the disease in the old tuber, and how it has infected the young plant. The stolon, 1 A, is uncontaminated.

The various kinds of vessels found in the stem are six in number. They are all seen in plate 6, which shows their natural position and arrangement. Those marked 1, plate 6, form the cuticle; 2, perforated vessels with hexagonal perforations; 3, vascular system, with diaphragms; 4, annular vessels; 5, spirals; and B 6, the medulla, or cellular arrangement. The cuticle, fig. 1, is composed of horizontal tubes woven together by a fibrous net-work. It is firmer in its texture and character than the other parts of the stem, and, like the leaves, is protected by hairs that terminate in a sharp point.

3. *Construction of the Tubers and Stolons.*

The tuber is composed of bark, cuticle, and cells, the chief

part, however, being cellular. The tuber has no external communication, and the skin, when set or hardened, is impervious to water. The cells of the tuber are its storehouses, and they are formed in the same way as those of the medulla of the stem; they have double walls, with tubular vessels circulating between them, and are hexagonal in form. Beyond these parts there are channels in which the gems are seated; these channels are passages or open courses filled with starch granules, floating in the waters of the tuber, and surrounded by cells filled also with starch granules. The channels are provided for the purpose of feeding the gems while germinating, and they are also probably the course by which the products of the plant are conveyed through the tuber to their destination. They join the cuticle at its inner surface, and from it strike inwards towards the centre of the tuber, and are thus admirably adapted for the conveyance of the products and the nourishment of the germs as well. The tubers, although the repositories of vitality, appear destitute of it themselves, and can only be viewed as receptacles for the products of the plant. A tuber is perfectly formed when no larger than a pea, for, upon examination, we find it to contain all the vessels found in tubers of a full-grown size. We discover no imperfection in it, even its little cells contain starch granules. The vessels of the tuber are merely a prolongation of those already existing in the stolon, as those of the stolon are a prolongation of those already existing in the stem. Thus, from the vessels of the stem both the stolon and tuber are formed; the stolon being the duct through which the products of the plant are conveyed to the tuber.

The stolon contains all the various vessels found in the stem, with the exception of the spirals, and its office is simply to place the tuber in a drier position than the roots, and convey to it the products of the plant. It lives no longer than the plant works, for as soon as the plant ceases to elaborate, the stolon ceases to convey, and its functions are at an end. When the plant has fully performed its office, the stolons dry and shrivel up; but should the powers of the plant be suddenly checked or totally suspended while its products are forming, the stolon, if in a damp situation, may putrify and decay, and thus infect the tuber to which it is attached.

4. *The Leaves—their Office.*

The leaves perform two functions, inspiration and transpiration. By inspiration they receive carbonic acid from the atmosphere, and probably nitrogen as well. The carbonic acid thus received is decomposed by the plant, its carbon being assimilated and retained with the products, while the oxygen by transpiration is thrown off as gas to the atmosphere. The leaves also exhale

water, and are generally considered to be the laboratories of the products as well.

In the solar rays the leaves throw off both oxygen and water; in the shade and at night, carbonic acid only. The light of the sun, therefore, causes secretion, and its absence retards or annihilates it. A plant like the potato cannot exist without leaves, and the leaves without the sun cannot perform their functions. While the solar rays act on the leaves, the plant increases in the amount of its products, and, consequently, in substance; but in a continuous shade it decreases by oxidation of its carbon and the liberation of the carbonic acid thus formed. The solar rays therefore produce a vital action, and their absence a chemical one; for secretion is the act of vitality, and the formation of carbonic acid the result of chemical action.

I have thus, as briefly as I could, given an epitome of the structure and functions of such parts of the plant as I shall have occasion hereafter to refer to in the course of the inquiry into the nature and cause of the disease. I shall now therefore proceed to notice the other matter connected with this subject, adhering to the plan of sections or separate heads, as affording more ready reference to any particular subject than when continuously carried on and intermingled with each other.

5. *Evaporation—its Laws. Exhalation from Plants and the Earth considered.*

The thermometer ranges in Britain from 0° to 136°. In the shade it varies from 0° to 89°, and in the sun it has not been observed to exceed 136°, which may therefore be considered its highest point. The difference of heat between shade and sunshine equals 57°, a variation of about 9° beyond the mean temperature of the year. The exhalation of water from plants, the earth, and surfaces in general, depends on the temperature of the air, the force and direction of the wind, and the hygrometric state of the air itself. If the temperature be low, and the air still and moist, evaporation is at its lowest point; but with rapid motion, dry air, and high temperature, it is at its maximum. The wind from N.E. to S.E., on account of its dryness, is more favourable for evaporation than from any other points of the compass, and exhalation is increased by about $\frac{1}{10}$ when the wind blows from these points, beyond what it is when it blows with the same force from any other part of the compass. If a still air represent 1 as the evaporating power of a surface, moderate motion increases it to $1\frac{1}{4}$, and a gale to $1\frac{1}{2}$. As the motion, temperature, and saturation of the air govern evaporation, exhalation is directly as its warmth, dryness, and motion, and inversely as these are receded from.

From this brief outline of the laws of evaporation, I shall proceed to state the particulars of some experiments instituted for the purpose of ascertaining the amount of exhalation from the earth as compared with that thrown off by plants during the same period of time.

I arranged an apparatus that contained two double metallic vessels of equal size, which were used as mould-pots. These vessels were so constructed that no moisture could escape except at the surface; while all superfluous water drained through to the reservoirs beneath, and could be returned again at pleasure. Each vessel had a gauge, that indicated the water in the reservoir. One pot was filled with mould only, the other with mould containing a polyanthus, and, thus arranged, they were each placed separately on a peculiarly formed balance, and connected with graduated vessels containing water. Thus contrived, they were balanced and charged with a given quantity of water from the graduated vessels, the indices of which could be read off at pleasure. They were now connected with the graduated vessels by a contrivance that made them self-acting.

Each pot contained 22·09 square inches of surface at the level of the mould.

The polyanthus contained 29 leaves, one side of which measured 66·54 inches at the commencement of the experiment, consequently both surfaces equalled 133·08 inches. The machine was set to work on the 28th of February in the present year, and regularly observed once or twice a-day, and its action and the temperature of the atmosphere registered. In twelve days from its commencement the mould alone had evaporated 1600 grains, which is 6·06 grains for every square inch of surface daily, while the polyanthus had evaporated 5250 grains, which, for the mould and one surface of the leaves, is 4·93 grains for every square inch. Deducting the evaporating power of the mould, 1600 grains, from that of the polyanthus and its mould, we have 3650 grains for the evaporating power of a plant containing 133·08 square inches in both surfaces of its leaves, which is equal to 2·28 grains for each square inch daily. Each day, however, was observed and the exhalation noted down, and, as might have been expected, the results varied. In cold sunless days the evaporation was either much lessened or entirely checked; while in warm sunny days it was the most active. The 1st and 2nd of March were dull cloudy days, and although the thermometer stood at 48° at 7 A.M., no exhalation took place during either of the days. The 3rd was a fine sunny day with wind, and the temperature 52°, or 4° higher than on the two preceding days. Here evaporation occurred to the extent of 198 grains from the polyanthus, and 290 grains from the mould-vessel. The succeeding days were

governed by similar circumstances, and, therefore, alike in action. A fine day with sun and wind always promoted evaporation, while a dull cold day retarded or entirely stopped it. The leaves of the polyanthus at the end of the 12 days were again measured, when the extent of one surface was found to be 67·26 square inches, that of the first measurement being 66·54, an increase too trifling to affect the calculations.

On the 8th and 9th of March, which were bright sunny days, the thermometer on the 8th at 6 A.M. stood at 36°, at 9 A.M. 50°, and at noon 83°, and on the 9th at 7 A.M. 32°, and at 9 A.M. 46°. In those two days the mould alone evaporated 250 grains, and the polyanthus 1500 grains, which is 5·7 grains for each square inch of the mould, and 4·83 for the polyanthus, including both surfaces of the leaves. On the 12th of March no evaporation took place during the day and following night; the weather at this period was dull and cloudy, attended with absence of sun, some rain, but no wind. The thermometer at 8 A.M. on the 12th stood at 42°, at 5 P.M. 46°, and on the morning of the 13th at 7 A.M. it was 36°. These experiments were continued until the 14th of April, a period of 46 days, when the results for the whole of that time were, that the polyanthus evaporated 17·500 grains, and the mould 11·000 grains, leaving 6·500 grains to be accounted for as exhalation from the plant. The average daily evaporation therefore for every square inch of the mould is 10·8 grains, and for each square inch of one surface of the leaves 2·01 grains, and for both surfaces half that or 1·005.

By a similar contrivance to that used with the polyanthus, I experimented upon 3 potato plants; the surface of one side of the leaves measured 46 square inches, while that of the mould equalled 132 inches. I commenced the experiment on the 19th of March, and concluded it on the 14th of April following, a period of 19 days.

The whole amount of water exhaled was 57·000 grains. This includes the leaves and stems of the plants and the surface of the mould as well. The evaporating power of the mould during that period equalled 10·8 grains for every square inch daily; this for 132 inches during 19 days, gives 54·000 grains for the mould, and 3000 for the plants, which, for each square inch of one surface of the leaves, is 1·4 grain daily, and for both surfaces $\frac{7}{10}$ of a grain only. The exhalation from the potato was therefore much less than from the polyanthus during the same period. Thus the potato gave 1·4 grain and the polyanthus 2·01 grains for every square inch of one surface daily. During the whole period of these experiments no rain or water, except that which has been noticed, came in contact with the plants and vessels; but although protected from rain, a free circulation of air was per-

mitted both night and day, and the plants continued healthy during the whole period.

In Hale's experiment on the sunflower, his mean evaporation was 15 grains for every square inch daily. This experiment was carried on in July and August for a period of 15 days, and evaporation is at its maximum in August, so that Hale's experiment was made at a period when transpiration was at its highest point. On the 3rd of March, however, the polyanthus transpired nearly 8 grains for every square inch, which, considering the season, is a large quantity. Transpiration increases progressively from March to August, after which period it declines. It is greater from sunrise till noon, after which hour it lessens. In my experiments I have noticed considerable evaporation from the earth, and transpiration from the plants as well, from 9 till noon, and I have also observed that it rapidly decreases from that period.

From the results of the experiments I have stated, it appears that the evaporation from the earth exceeded by five times that of the transpiration of the plants. Now, if this ratio should continue until we reach the highest point in August, and we take Hale's mean of 15 grains for the potato, we shall have 81 grains for the earth as a mean for each square inch of its surface, which gives an evaporating power for every acre of land of 318 tons daily during the months of July and August. And if this acre contain 26,800 plants at 1 foot apart, and 15 inches between the rows, and each plant an area of 400 square inches, we have for exhalation from the plants rather over 10 tons daily. This sum of transpiration added to the evaporation of the earth, gives a total of 328 tons as the average amount of water vaporized from 1 acre of plants daily during the months of July and August. Let us now briefly consider

6. *The Influence of Light on Plants.*

The solar rays stimulate the organs of plants and increase their action. In the direct rays of the sun, plants decompose carbonic acid, and throw off oxygen. In the shade and at night the vitality of the plant is so lessened that it absorbs oxygen and liberates carbonic acid. The absorption of carbonic acid and the liberation of oxygen is a vital action, but the absorption of oxygen and liberation of carbonic acid is a chemical one.

Vital action increases the weight of the plant by assimilation of carbon, while chemical action decreases its substance by the loss of it. Light forms the green colouring matter of plants (chlorophylle), and also changes the nature of the sap by its action on the organs of the plant, and thus imparts life and vigour to the system. Without the solar rays the juices of a plant become attenuated, and its secretions and circulation impeded; and if the

absence be long continued it suffers in proportion. In short, it may be said that light is as essential to the well-being of a plant as water, air, and even the integrity of its own organism, for without its presence that organism cannot long act. Deprive a plant therefore of light, and you rob it of a stimulus that nothing can supply, and without which it cannot healthily exist. From these brief considerations of light, which we shall have occasion hereafter to refer to and enlarge upon, I shall pass to the next part of our subject, which is—

7. *The Fungi and Insects observable in Diseased Plants, with some Remarks on their Nature and Office.*

The fungi which I have observed in diseased plants and tubers are as follows:—

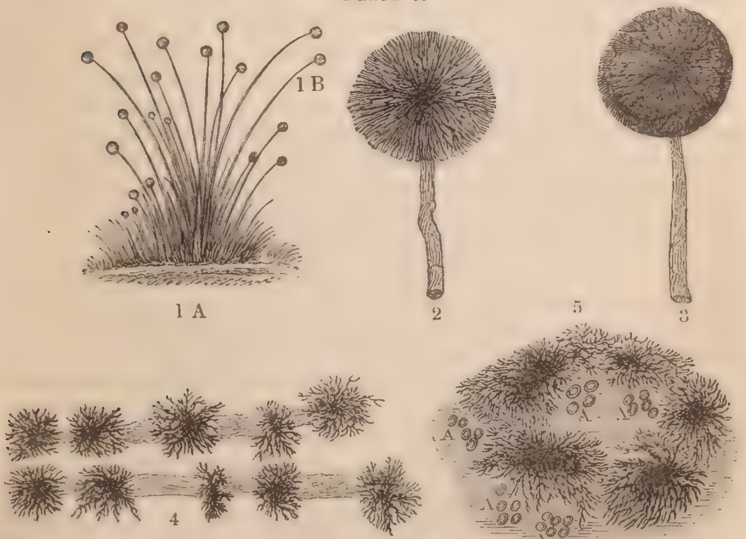
1. A short white fibrous fungus that lies close to the surface of the tuber on which it grows, such as is represented at the base of the boleti, plate 7, fig. 1 A. This kind is seldom found in very putrescent tubers, as much moisture destroys it. It thrives best on slightly moist surfaces in a dark place.

2. The round-headed or boleti kind that grows on a long slender tube, such as is represented in plate 7, figs. 1 B and 3. This kind I have only found where putrescence exists: moisture and absence of light appear essential to its existence.

3. Radiated fungi, such as is seen in plate 7, figs. 2 and 4.

4. Botritis infestans, a grape-like fungi. See plate 8.

PLATE 7.

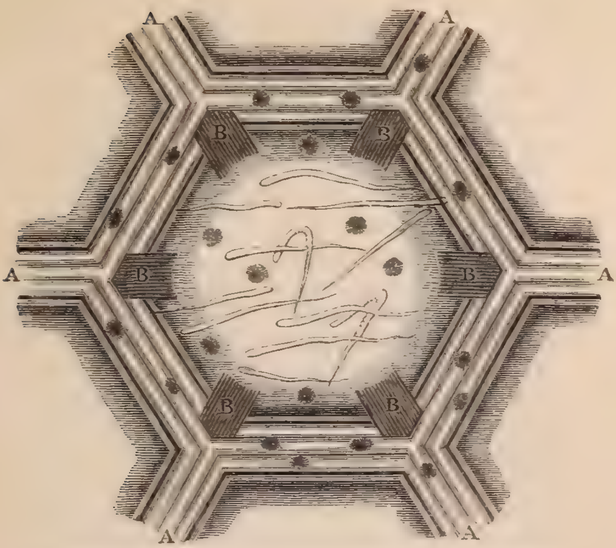


Mould, Fungi, &c.—Power of object-glass used, 480 diameters.

These four kinds of fungi are all that I have observed, and they appear the effect of different causes. The first kind is an external fungus, growing only on the outward parts of vegetable matter. It is readily produced by placing a piece of potato, wood, or any similar substance, in a dark damp cellar for some days or weeks, as the case may be, when it will appear in white patches on the substance thus treated. It has no sensible action on the substance it attacks, for it will grow on sound pieces of potato without injuring their texture. I have submitted pieces of potatoes to its action for five consecutive months, and have found them perfectly sound and uninjured at the end of that period.

The second kind, however, is of a different character, although it appears and may sometimes be seen growing up from among the first; yet the two cannot long thrive together, for the second requires moisture, and the first comparative dryness. If much moisture be present, putrescence exists, and the second kind advances while the first recedes; but if it be tolerably dry, the first flourishes and the second dies away. The second is the offspring of putrescence, and it flourishes only in such kind of matter. It is formed of a single footstalk terminated by a head. The footstalk is simply a tubular vessel, and the head a hollow globe seated on the apex of the footstalk. As the fungus arrives at maturity, the globe or ball changes from white to a light brown colour, at which period an insect of the apode or eel tribe may be discovered in it, such as is found in some diseased plants, and represented in plate 1. In last November and December I made some experiments as to the propagation of this fungus in the potato, by inoculation and by the seed, if it contains it, by crushing the heads on pieces of potato, but without success. Soon afterwards, however, I discovered that it might be produced by putrescence, and that without any difficulty. All that is required to generate it in a potato is to first bring the potato to a putrescent state, and place it in a damp and moderately warm atmosphere, where little or no light is admitted; and in the course of a few weeks it makes its appearance. I have closely examined the globules or heads for seeds, but have in no instance discovered any, although I have employed a most powerful compound arrangement, using an object glass of 480 diameters. As this kind of fungus appears only with putrescence, and seems to contain no seed, it may probably be produced by the eel-like insect that inhabits the head, in a way something analogous to the generation of nut-galls. This idea is probably correct, and seems strengthened by the presence of the insect, the absence of seed, and that it cannot be propagated. Putrescence may be induced in a sound potato by immersing it in water for some weeks, and

PLATE 1.



Diseased Cell as observed in stem, at a joint, in this season's plant.
Power of object-glass used, 480 diameters.

afterwards exposing it to a damp, dark, and moderately warm atmosphere. A temperature of from 40° to 60° will do very well.

The third kind, which I have called radiated, from its form and general appearance, is found only internally among the vessels of the tuber and plant. I have never observed it until disease has made considerable progress, when it frequently appears as an elongation of the vessels and fibres. It is difficult to determine whether many of the masses that resemble fungi be so or not; for the brown colouring matter which always accompanies the decomposition of the vessels, not only renders an examination of them burdensome, but presents such a diversity of form as renders it vexatiously troublesome to distinguish the ultimate fibre from the fungus itself; but although in some cases this difficulty occurs, yet in others, as a compensation, we have none whatever, for we perceive the vessels and the fungi growing from them, as represented in plate 7, figs. 2 and 4. Fig. 2 is the form in which it is found in the stem in the first stages of the disease, and fig. 4 in that of the tuber.

Putrescence produces this kind as well as the boleti; and wherever the boletus appears, the radiated fungus always accompanies it, the radiated being internal, and the boleti external.

The radiated form, fig. 4, plate 7, grows from, and is generally

found attached to, minute vessels in the tuber; sometimes it is seen vegetating from the channel at the end of a broken vessel, and at others from the side; and it may be seen in various other forms also. Its chief characteristics are its adherence to a vessel, its fibrous form, its appearance with putrescence, and its secret habits, growing only internally.

The fourth is the botritis or grape-like fungus. It grows on a hollow flat oval stem externally, but on a cylindrical tubular one internally. Externally, the stem at its apex is loaded with seed, arranged sometimes in the form of grapes. The seed is white, and so is the stem generally, but at times it is found dark-coloured. The form of the seed is oval, and they are so minute that I found them to measure from ·000001 to ·000005 of an inch in length only. The structure of this fungus is simple: its peduncle is a hollow membranous stem, to which the seed, formed of the same substance, is attached. The seed has a refractive power somewhat superior to water, and analogous to that of potato-starch, with which it agrees in density, form, and colour; and so well does it resemble potato-starch, that if mixed with it in the tuber it could only be distinguished by the hilum, which granules of potato-starch do not possess.

There is no difficulty, however, in detecting this fungus in the stem, leaves, and hairs of a plant, as the seed and stem are generally found united to each other, in which state they cannot be mistaken. I have discovered it in all parts of the present year's plants, but not in the tubers. I have traced it from the stem, as it issues from the set, through its entire length to the leaves, in the leaves themselves, and even in the hairs also; but by the most minute examination I have failed to discover even a trace of it in the young tubers, or the sets from which the plant grew. Plate 8 represents a cell infested with it. This cell was found in a cutting taken from the base of a stem immediately above the old set. The procreative power of this fungus is so great that it exceeds calculation. Myriads of seeds are contained in a single cell of the potato plant; and they are so minute that a pea of one line in diameter would, according to my measurement and figures, contain the astonishing number of 800 billions of them. I have discovered it in this season's plants, both externally and internally; and I have seen its small fibrous tubes adhering to the hairs of a plant until the apex of the hair has become so loaded with its seeds as to be no unapt representation of a knotted club. This fungus seems to precede all the other kinds we have noticed, and to disappear as they become sensible. Thus we find the botritis in the apparently sound parts of the leaves and stem accompanied by no change of colour; then we find the radiated in the stem and tuber, with change of colour; and, lastly, the

PLATE 8.

Diseased Cell, from the base of a stem of this year's growth, containing the grape-like fungi Botritis infestans.—Power of object glass used, 480 diameters.

boleti or round-headed, with putrescence. The botritis attacks a plant both externally and internally, but its character varies according to the situation it appears in. Externally it grows on a single stalk, surmounted by numerous sporules or seed-vessels, arranged in a mass at the apex. No roots can be perceived, and it appears to attach itself only to the mere surface of the cuticle. Internally, in the first instance, a shoot springs from a single seed, which vegetates, forms a stem, and fructifies. The offspring and parent continue together, and new generations rapidly develop themselves, the whole being connected together by the branches formed of the peduncles. Thus a ramification of stems and seeds, that spread in all directions, soon exists, which, as seen by the aid of a microscope, suggests the idea of a leafless vineyard loaded with fruit. The prolific power of this fungus, if viewed as a destructive agent, gives it an appalling character. Its minute seeds circulate through the vessels of a plant, and vegetate in its sap and juices. It adheres to the walls of the vessels, throws out its branches, and chokes up the passages, and the rapidity of its growth soon enables it to infest all parts. The exterior as well as the interior of the vessels are alike the subject of its attacks, and no part of an infested plant can long be free from its presence. If we observe the minuteness and simplicity of a seed of this fungus, and afterwards examine its vegetation in a diseased plant, we feel astonished at the fecundity and power of so small and apparently weak an object. We perceive that a

single seed, whose diameter may be the one millionth of an inch, has generated countless numbers of bodies like itself, all of which possess the same fruitfulness, and prepared in their turn to generate others also. Seed upon seed, and branch upon branch, are thus formed with a rapidity that sets at nought all computation, and bewilders the mind by its extent and complexity. Let a plant therefore become infested with the botritis, and what will be the effect? The answer to this is apparent. The vessels of a plant are what veins and arteries are to an animal—the channels of circulation; and if these be gradually choked up, circulation is impeded, and vitality lessened; and if the cause continue until circulation is suspended altogether, vitality ceases, and the plant dies. Such would be the fate of a plant infested with the botritis, for it has within itself an enemy that cannot be shaken off; for it circulates with its juices, feeds upon its organs, chokes its channels, and destroys its vitality.

I had four geraniums and a fuchsia cut down by exposure to several frosts in February and March. These were placed in a warmer atmosphere, and in the course of some weeks I observed an efflorescence on the mould. This efflorescence was principally white, mingled with a few patches of yellow and brown. On my first observing it, I supposed it to be some salt of lime, probably carbonate, and thought at the time no more of the subject; but finding subsequently that some of the plants were apparently dead, and the efflorescence increasing, I examined it, and found it to have in every respect the character of the seeds of the botritis. I examined more minutely, after this discovery, into the nature of other similar efflorescences, and I found the same character in many of them: they were clearly the seeds of the botritis. One of the geranium pots contained the efflorescence so abundantly that I could have filled the cuticle of an ordinary pea with it. This equals a globule two lines in diameter: there must therefore have been on the surface of the mould of that one pot 1600 billions of the seed of this fungus. But what is this number compared with what must be in existence? If in a single flower-pot, some 7 inches in diameter, we find a number so great as far exceeds our imagination of it, what, I ask, must be the total of these existences in the whole world? The mind is overwhelmed by the thought, for we cannot comprehend it. Great as the powers of the human mind undoubtedly are, here is a subject so minute in size, yet so abundant in numbers, as to elude its grasp. It laughs at figures, and defies their application to solve the problem.

The seed of this fungus we find in the earth, so that we have no occasion to bring to our aid any extraordinary agencies for its propagation. We require neither wind, birds, nor any other

thing to spread it about. The earth is its depository, and perhaps matrix as well, for there we find it; but although we find it in the earth, we have no reason to think it placed there to act as a destructive agent of healthy vegetation, or as an antagonistic principle with which plants in general have to contend, or, in short, to view it as an enemy to vegetable life. But as we find this fungus in plants, and see its effects on them, we may ask, if it be not destructive of healthy life, how it is that it appears in them? This I shall endeavour to answer.

We have seen that four kinds of fungus may be discovered in diseased potato-plants, and that they appear in different states of matter. We have the botritis and fibrous fungi, without change of colour; the radiated, with change of colour preceding putrescence; and lastly the boleti, with putrescence only. We have here then something like cause and effect, for we perceive that a certain condition of matter contains a certain kind of fungi, and that the boleti is always the last that makes its appearance, and that it only appears when putrescence has set in. From these circumstances it may be inferred that different kinds of fungi require different states of matter to appear in, and that the condition suited to one kind is not suited to another, as we never find the order in which they exist inverted. We do not find the boleti in apparently sound matter, and the botritis in putrescent, but on the contrary; and their appearance is regular according to the condition or state of the matter in which they are found, so that the kind even indicates the state of matter. This regularity and order of appearance, marked by definite states of matter, permits two views to be taken of the subject:—

1. That each kind requires a certain condition of matter to vegetate in as a matrix, hence the appearance of the different kinds in different states of matter.

2. That the different states of matter are the effect and not the cause of fungi.

As these views are opposed to each other, I shall briefly consider the facts we are in possession of, and adopt that as the most reasonable which best accords with them.

The fecundity of the botritis, as we have seen, exceeds all calculation; and as it is generated by seed, its origin is unequivocal, and its antiquity must therefore be equal to that of all other vegetable beings. Now if the botritis be viewed as destructive of healthy vegetable life, its attacks would be general, and we should find it always in action; and calculating, from its prolific nature, that its increase is as the ratio of its attacks, we have in this minute being, if such were its office, a power more than sufficient to have long since destroyed the whole vegetable kingdom; but so far is the botritis from possessing such fearful powers, that we

are unable to trace it as a primary destructive agent of healthy life at all. It is seen in diseased plants, but we have no proof that it is the cause of the disease; while, on the contrary, we have proof that, by inducing disease, it makes its appearance.

The habits and nature of this fungus are indicative of its powers; and we shall now perceive these powers to be very limited, and due to certain conditions of the natural elements. Thus the light of the sun destroys it, and drought is fatal to it also. It thrives only in damp and dull atmospheres, and its habits are altogether secret and saturnine. Now as the earth appears a depository for the seed, and even a matrix as well, under certain circumstances, we can perceive how the seed may always be present, and ready to attack any matter prepared for it, supposing it to require a particular condition of matter to vegetate in; but if we admit the general presence of the seed, and view it as a destructive agent, we cannot see how its attacks should be partial. Again, if we admit the necessity of a certain condition of the natural elements, such as wet, want of sun and cold to develop it, we admit that, which proves as much a partial condition of matter as it does a partial and limited action of the fungus itself.

The habits and nature of the fungi, the condition of the matter they are found in, and all our knowledge and experience of them as well, therefore teach us that they are not destructive of the vitality of plants as a primary cause, but rather that they appear in a particular and unhealthy condition of them to prepare them for further changes.

The eel-like animalcules that I have mentioned as existing in the heads of the boleti are generated in abundance by putrescence. I have produced them by immersing whole and cut tubers in water for some weeks, and afterwards exposing them to a dark and gloomy atmosphere. They are also produced by putrescence in any other similar matter, and are therefore not peculiar to the potato. All vegetable and animal beings, while undergoing decay, are subject to the attacks of numerous kinds of fungi and animalcula. We have not sufficient evidence to show where the germs of the whole of this minute race of beings exist; and although in some cases we may trace them, yet our knowledge of the mass is very deficient. There are peculiarities in the habits of these beings. Thus some animalcules and fungi appear only in one class of subjects, others again in another class, and inert organic matter seems devoted and apportioned to them in sections. Wherever their services are required they appear; for no sooner is a body, either vegetable or animal, in the state to require their presence than these scavengers of organic matter are seen actively at work. There is a wisdom in this arrangement, and a bene-

ficence in the provision, for it renders that last change of matter which all organisms are doomed to undergo less hurtful to the living and more conducive to the purposes of vegetation. We have seen that the botritis grows and fructifies with great rapidity, that it produces myriads of seeds, and that they are to be found in the earth. Now, if its office be to destroy the life of healthy vegetation, we may ask what has it done to support that character? Has it ever destroyed a single corn-field, devastated our fruit-trees, or ravaged our gardens? Has it been known to bring forth its countless legions, and, like the deadly blast of the simoom, sweep all before it? Has it, in short, ever robbed the earth of its green and beautiful covering, and converted it into a desert? Nature replies, no; and the experience of humanity responds to it. If, then, it has not acted generally, its attacks have been partial; and if partial, particular; and if particular, under certain conditions, that must have governed the act committed; and as particular action is opposed to general, so may we conclude the appearance of the botritis to be the effect of circumstances—a mere agent of the condition of things, and that its nature and habits unfit it to act generally. The other kinds of fungi observable in potatoes need not be noticed, as they are clearly referable to the state of matter in which they appear. It is not to be denied that ravages have been committed by insects, in some cases to an alarming extent; but these, fatal as they may have been, have not the least connexion with our present subject in character, except as far as they may be traced to some peculiar state of the elements; but although such cases are not identical in nature with fungi, they may nevertheless be usefully contrasted with them as instances of ravages in the vegetable kingdom, and with that view I shall briefly mention a few.

In June, 1830, a singular scene presented itself among the oaks in the weald of Kent. They were, from a state of luxuriant foliage, suddenly stripped of their leaves by the united attacks of myriads of caterpillars. Linnæus states that the corn in the granaries of Sweden, for several years, was attacked by the Musca hordei, and that it sustained an annual loss of 100,000 tons. Some years since the Hessian fly devastated the wheat-fields of America; and a species of locust, the Gryllus migratorius from Tartary, laid waste a great part of Europe. Turnips suffer from the Haltica nemorum, or black jack; cherries from the Tephritis cerasis, or cherry-fly; and the blossoms of the apple from a moth; the bark of trees from the Tinca corticella and the Aphis lanigera; and other cases in which vegetation suffers from the depredations of insects might be named. Animals are not exempt from these attacks: thus oxen and cows suffer from the Œstrus hæmorrhoidalis, or bot, internally; sheep from the

eggs of the Œstrus oris in the head; and the forest-fly (Hippobosca equina) is frequently troublesome to cattle. It will be seen that these instances bear no relation to fungi, neither are they parallel nor in any way similar to the potato disease: they merely show that insects have committed ravages, and that a certain loss was sustained in consequence. We have no evidence that in these attacks the vessels only of the plant and animals suffered, and that in consequence they perished by putrefaction. On the contrary, the attacks appear to have been generally of an external character, and mostly local in their action, being principally confined to a small sphere, and frequently not extending beyond a few individuals.

8. *The Commencement and Course of the Disease in the Stem and Tubers: its observed Action.*

The commencement of the disease has been a subject of some dispute—one party pointing to the leaf, another to the stem, and a third to the tuber; and cases have been named in support of each. The most numerous testimony, however, points to the stem as the part first observed, and some few to the leaves. I shall not, however, enter deeply into the merits of these opinions, as it is of little moment where the disease was first observed, provided we find out the cause; but, for reasons which I shall hereafter state, I view the stem as the part where it commenced, notwithstanding any apparent proofs to the contrary. The first external appearance of disease, in the stem, was marked by a deepening of colour, accompanied by an enlargement of the affected part, and succeeded by a weeping or exudation. As the disease advanced, the part of the stem affected became soft and pulpy, and the colour changed to a yellowish brown. The stem was generally, if not universally, first affected at a joint, or the part from whence a lateral branch springs; and the leaves above the diseased part blackened, drooped, and died.

Now from the striking appearance of the leaves, a casual observer would conclude they were the parts first affected, and considering the body they present as compared with the stem, and also the significant change of colour and drooping they undergo, it is no unreasonable view of the matter. But reasonable as this view may appear for a glance, a more searching examination of the subject shows it to be distorted: for we shall be enabled to trace the disease through its stages to its seat, and thus identify the part from which it sprang in the stem; and if we succeed in this, it will be seen that the condition of the leaves is referable to the stem, and that their change of colour and drooping is the effect of lessened vitality caused by a gradual cessation of communication between the upper and lower parts of the plant, by a

breaking up of the vessels, and that eventually, as the disease advances, all communication ceases, and the upper parts of the plant die.

I shall now state the results of an examination of seven plants of this year's growth visibly affected with the disease, and identical with that of the last season.

These plants were forwarded to me by a gentleman of great practical knowledge, and better specimens for the purpose could not be desired. The stems were all connected with the parent sets, so that I had foliage stems, young tubers, roots, and sets complete. The upper part of the stems and leaves of the diseased plants had the dull and heavy appearance so characteristic of the disease; and nearly the whole of the stems were more or less affected at one or other of the joints whence the lateral branches sprang from. In some of the plants the stem was most affected at a particular joint, in others the smaller branches and leaves were the most injured. No trace of fungi or insect was discoverable in some of the affected stems beyond the immediate localities of the diseased joints. The disease in those cases had not extended itself, and was confined to a space not exceeding one inch of the length of the footstalk. In other cases the disease had spread both ways for a considerable distance from the wound, confining itself chiefly to the medulla. Fungi of the boleti and stellate kind were observable in all the diseased stems; and at the parts where putrescence existed the eel-like animalcula abounded. The stem of one of the plants was hollow, the medulla having apparently lost its vitality, and died away. The hollow part extended to about three quarters of the length of the stem, from the root upwards. On examining the stem by thin transverse and longitudinal sections, I observed that the vessels which traversed the walls of the cells were filled with a rich brown coloured fibrous mass, the form of which could only be distinguished at the angles of the cells severed by the cutting. The vessels also contained fungi of a similar colour to the fibrous mass, arranged in a star-like form; these masses of fungi had pierced the walls of the cells in some instances, and appeared approaching their centres. The colour of the fungi imparted a tinge to the cells, so that the most diseased ones appeared brown. Plate 1 represents the fibrous mass at the angles, and also the stellate fungi, as seen in the cell and vessels.

One of the plants contained two diseased and one sound stem; the stems were attached to the sets, and young tubers were formed on some of the stolons. I dissected the whole of the stems, and traced them microscopically downwards to the parent set; the two diseased stems sprang from separate germs: one of them from the crown or principal eye, and the other from an adjoining lateral

one. The sound stem originated in a germ somewhat lower in the tuber. On dissecting the old tuber or set I discovered that the two diseased stems were the offspring of diseased germs, and that the sound stem sprang from a sound germ. Previously to dissecting the old tuber or set I carefully examined it, but could discover no trace of disease from its external character. The cuticle was clean and healthy, and no external examination could possibly have detected the disease existing among the germs. The state of the set indicated the disease to have existed from the last season, for the infected parts were deep seated; and as no abrasion of the cuticle could be found in any part of the tuber, its origin could not proceed from any external or outward influence acting on the set. Another tuber or set to which two stems were attached, contained one sound and one diseased stem, which I as carefully and microscopically examined as the former one, and with the same results. The diseased stem sprung from a diseased germ, and the sound stem from a sound germ. This cause and effect so plainly revealed in these instances, induced me, notwithstanding the labour, to continue the examination with the remainder of the plants, the stems of which were all visibly diseased, and I met with the same unvarying results; for the whole of the diseased stems were the offspring of diseased germs. The sets from which these plants grew were all of them outwardly sound, and from their appearance I judge they had been selected with great care for the purpose of seed. The stolons on the diseased stems were dead, and the growth of the tubers consequently stopped; but to the sound stems sound stolons existed, to which were attached tubers: these I examined, both from the sound and diseased stolons, but could discover no trace of fungi, insect, or any indication whatever of disease.

In the last season's plant fungi were generally discovered by several authorities; among whom may be mentioned the Rev. J. M. Berkley, Prof. Morren, and M. Payen. These gentlemen found the botrites fungi invariably preceding the disease, in the specimens they examined. But in many plants that I examined I failed to detect them, although the tubers were much diseased. In the examination of this year's plants I discovered the botritis in some of the stems, and externally on some of the leaves, while in others no trace was perceivable. I have said that the cause of the diseased state of the leaves is referable, and may be traced to the stem, and that the stem, so far as the affection of the leaves is concerned, is the seat of the disease. Let us now see what evidence we have to support this view of the case. In all the examinations that I have made of the superior parts of a diseased plant I have invariably found the medulla of the stem to be the most seriously affected; and in many instances where the leaves pre-

sented an unhealthy appearance, and the cuticle of the stem appeared sound, I have found the cellular arrangement of the medulla much diseased. And in those cases where the disease was in an advanced stage, so that it could be distinguished externally, by a discoloration or decomposition of the cuticle, the medulla was always the most diseased, being generally putrescent.

The disease of the stem, I have generally observed, is limited to the joint attacked, and seldom extends itself longitudinally to any distance, being confined within the space of a few inches of the affected part. In the same section the medulla will be much diseased, while the vessels and cuticle surrounding it will be quite sound, and if putrescence exists the medulla is always the most affected, the disease penetrating the medulla and leaving the surrounding vessels and cuticle frequently untouched. Where the stem has putrified and rotted off, examination proves the seat of the disease still to be the medulla; for if we continue our researches by sections transversely made, we come to parts in which we find the medulla much diseased, and yet surrounded by sets of vessels and cuticle that are quite sound. And pursuing our researches, we further find that the diseased parts of the medulla extend below the sound vessels and cuticle that surround it in the form of an inverted cone. We have evidence, then, in these facts, that the medulla is the seat of the disease so far as regards the stem, and if we consider the nature and mode of the circulation carried on in the plant, we shall readily perceive why the leaves present the appearance they do when the plant is diseased, although the seat of it may be distant from them. The sap flows upwards from the roots through the medulla and vascular system, as has been noticed in the vegetation of a germ, in section 2, page 303. It then passes through the leaves, is acted on by light, and becomes the cambium or prepared sap containing the products of the plant. Now as the cellular arrangement of the medulla is necessary to the circulation of the plant, its integrity is essential to a healthy action; and if its cells become disorganised, so that a full and proper supply of sap cannot reach the leaves, they droop for want of nourishment; and if the disease of the medulla spreads, so that the whole of its organism is destroyed, all the parts above where it is affected are cut off from communion with those below, and although the plant may exist for a time, yet so far as the elaboration of its products is concerned, it is dead. If the seat of disease in the stem be below the leaves, which has universally been the case, the whole of the foliage dies and presents the appearance that has already been described. There is nothing however peculiar in the colour and appearance of the leaves of a diseased plant beyond what is observable in preliminary stages of putrescence: for if the foliage of a healthy potato-

plant be cut from its stem while full of sap, and the changes that ensue noticed, all the phases of the disease will present themselves. First, we have the deepening of colour, attended with the liberation of carbonic acid, then the dull heavy hue preceding putrescence; then the dark brown hue that appears with putrescence, and finally, the disorganisation of the mass itself by putrefaction. The character of the leaves then observable in the disease is due to incipient putrefaction, for it presents no peculiarity beyond what takes place in all vegetable matter while undergoing that change when similarly circumstanced to the leaves of the potato-plant.

From a consideration of the commencement of the disease in the stem, I shall now trace it through various parts of the plant, and notice what takes place by its action. If we examine a diseased plant, we never find the roots affected with rottenness, although the stem and tubers may be putrescent. Continuing our examination from the root upwards, we find nothing remarkable until we arrive at the base of the footstalk. At this part we sometimes find the botritis located in the cellular arrangement of the medulla, and vegetating luxuriantly. Continuing our course up the stem, having found the botritis at the base, we still trace it, and as we approach the first branch the colour of the medulla deepens, and some disorganisation appears in the walls of the cells; passing onwards until we reach the joint, putrescence presents itself, and the cells of the medulla are broken up. Here we find the eel animalcula, together with abundance of boleti and radiated fungi; still pursuing our way, we find, after passing the joint, traces of boleti, but as we approach the foliage we frequently lose them altogether. Taking our course now from the stem along the stolon to the tuber, we find no fungi but that of the radiated kind; passing to the tuber, we trace the disease through the passage of the stolon, along the channels of the germs, through the empty cells, beneath the cuticle, the vessels and walls of the cells, and lastly, in the vessels which are in the germs themselves.

This is an epitome of the course of the disease, and what may be traced in all cases, the only variation being that of intensity. It is peculiarly a disease of the vessels and not of the products, for the starch granules may be found perfect in the midst of putresence. From the circumstance of the botritis appearing at the base of the stem, and increasing in force until we reach the joint affected, and also from its frequently disappearing as we approach the foliage, it appears that the leaves are not the first point attacked, but rather that the disease ascends with the sap from the roots. This view is strengthened by the fact that we can trace no starch below the stolons after the plant has formed leaves; and from this fact we may conclude that the downward

current of elaborated sap extends not beyond the stolons, and yet the botritis is found below them ; and it is found, too, only in the medulla, the chief reservoir of the upward flow.

9. *Chemical Changes induced by the Disease.*

The changes induced by disease are, according to chemical analysis, clearly referable to putrefaction. But chemical analysis not only shows the disease to be that of putrefaction by the loss of azotised matter, but it supplies further evidence that the disease is a disease of the organs and not of the products—from the circumstance that the organs are the reservoirs of azotised matter, and it is azotised matter that suffers the greatest loss.

I now present the results of two analyses made by myself, and which closely agree with those made by Dr. Playfair upon similar specimens:—

	Sound Tuber.	Diseased Tuber
Water	75·21	78·61
Starch	15·92	16·01
Sugar	0·67	None.
Colouring matter, flavouring and Resin	1·02	0·62
Gum	1·25	1·17
Albumen and Gluten	2·34	0·32
Ligneous fibre	1·24	1·02
Silica, Alumina, Lime, Potash, Magnesia, Phosphoric and Sulphuric acids, and Chlorine	2·35	2·15
	100·00	99·90

The variations presented by these analyses in the constituents of the sound and diseased tuber are, that the diseased tuber contained 3·4 per cent. more water than the sound one; the starch may be considered the same, as the difference is trifling; the colouring, &c., is somewhat lessened and the sugar gone; the gum is unchanged, the albumen and gluten nearly destroyed, accompanied with a slight loss in the fibre.

The inorganic constituents agree, if the excess of water in the diseased tuber be considered in the calculation. The most significant change that takes place in the constituents of the tuber is that of the disappearance of the albumen and gluten. These substances contain azote or nitrogen, and azotised bodies are prone to change when placed in favourable circumstances. A sound potato contains a free acid, and reddens blue litmus paper when applied to it; but when the disease has set in, ammonia is generated by the decomposition of albumen and gluten, and the potato becomes alkaline. Now, ammonia contains hydrogen and nitrogen in the proportion of 3 equivalents of the former to 1 of the latter; and hydrogen and oxygen form water; and water, carbon, and nitrogen form albumen and gluten. Hence the decomposition of the azotised matter furnishes ammonia as well as

other products, and sufficiently accounts for the alkaline state of a diseased tuber. This is the case with the stem and the foliage also, which are acid in their action on litmus paper while in a healthy state, but alkaline when putrescent. Pure starch and gum contain no nitrogen, they are therefore more stable products, and not so easily acted on as azotised bodies; hence their integrity in the midst of the decomposition of the other bodies. The colouring matter produced by the disease is insoluble in water, ether, alcohol, acids, and alkalies. Sulphuric and hydrochloric acids dilute, render the colour somewhat lighter, but do not dissolve it. This colour is produced by the presence of oxygen, but by no other agent that I have tried. Nitrogen, hydrogen, and carbonic acid produce no change of colour, but atmospheric air does, and the atmosphere is composed of nitrogen, oxygen, and carbonic acid. Now, as oxygen produces the colour, while nitrogen and carbonic acid do not, its appearance must be owing to oxidation; and as this colour is found in the internal parts of the tuber, where no direct contact with the atmosphere exists, it seems probable that its production in such parts is attributable to the liberation of oxygen during the first stages of putrescence, as we can only account for its production by the presence of oxygen. Healthy tubers, however, contain air, as may be seen by placing them in water previously divested of it under the reservoir of an air-pump, and exhausting the receiver. But the air thus confined will not account for the colour, as it only appears with the disease. All the phenomena of colour observable in a diseased tuber may be produced by exposing thin slices, or what is better, grated portions of potato, to the action of the atmosphere, Should the potato thus treated have lost much of its water by evaporation an addition must be made to it, or the action will be slow and uncertain. The first change that we observe is that of the colour becoming yellow, then light brown, reddish brown, deep brown or umber, and lastly, black. At the first, or yellow stage, an aroma is perceived, similar to that of olive oil; this increases in intensity until after the black stage, when putresence sets in, and we then lose the olive oil aroma and perceive that of caseic acid. The smell of caseic acid is perceivable until a fœtid odour arises, which is the last stage that presents itself until putrescence has run its course, when all smell ceases.

All the diseased tubers that I have analyzed contained more water than the sound ones, generally from 3 to 4 per cent.

According to Dr. Playfair, the tubers of former seasons contained from 62 to 68 per cent. of water; the first being the minimum, and the latter the maximum amount generally found. In the examinations that I have made I have found 78 per cent. in the sound tubers of last season, the whole of which were free from

visible disease, both externally and internally. Comparing, therefore, the tubers of former years with those of the last season, we have an excess of water in the last year's growth of 10 per cent.; and as the diseased tubers contained more water than the sound ones, excess of water seems a feature in the case closely connected with the disease itself. The tubers of last season, when first taken

PLATE 4.

Transverse section of Diseased Tuber.—Power of object-glass used, 320 diameters.
1. Bark. 2. Cuticle. 3. Reservoir of empty cells. 4. Channels leading to the gems or eyes. 5. Cells diseased. 6. Cells not diseased.

from the ground, rapidly passed through the various stages of the disease, but after drying their surfaces by exposure to a current of air, their putrescent form was arrested and another phasis presented itself. Thus, instead of the tuber becoming pulpy and rotten, and emitting a cheese-like, and afterwards a fœtid odour, it would harden and appear outwardly sound; but when examined internally a dark reddish brown coloured matter, of a leathery texture, presented itself. In this state the disease silently spread through the tuber without emitting any offensive smell, and the tuber appeared as if affected with the dry-rot. The black colour of the worst stages of the disease may be produced by immersing for some time cut slices of potatoes in solutions of any neutral salt, and afterwards exposing them to the action of the atmosphere. Acids, alcohol, ether, tannin, and alum (sulph.

of alumina and potash) prevent the formation of the black colour, and consequently putrescence also.

Sulphuric, hydrochloric, nitric, oxalic, tartaric, and acetic acids, moderately diluted with water, soften cut slices of potato, and for a time prevent putrefaction. But after an immersion of two or three months the potato becomes disorganized, but does not blacken although exposed to the atmosphere for three or four months, but yet decomposition ensues notwithstanding. Tannin, tannic and gallic acids, and alum, harden slices of potato and prevent putrefaction: they have great antiseptic properties, so far as regards the potato.

10. *The adaptation of the Plant to certain Conditions.*

In the arrangement of the potato plant we have seen that it possesses a considerable extent of roots and numerous absorbents, and that the roots are so contrived that they lie below the stolons to which they are attached, and thus place the stolons and tubers in higher and drier soil than themselves. This is a striking arrangement of parts; and the inferences deducible from it are, 1st, That the roots, having numerous absorbents, are intended for a comparatively dry situation; and, 2ndly, That the tubers are intended for a drier situation than the roots themselves. A plant formed for a moist or damp soil has no need for the thousands of absorbents that the potato possesses, because if the whole of them are to be usefully employed they must be placed in a situation where they have to seek moisture, and not where they are embedded in it. Contrast the potato with the turnip, and this will be apparent. In the turnip, but few roots and spongioles appear, and it needs moisture in its culture, while, on the other hand, the potato possesses numerous absorbents; and we know by experience that it thrives best in comparatively dry situations. The foliage of the two plants is as characteristic of their nature as the roots themselves, and furnish us with additional evidence of their wants, and the means by which nature has contrived to supply them. In the potato the foliage is high, and evaporation from the soil is but little impeded by it; while in the turnip it is low and wide-spreading, and evaporation is consequently much impeded by such an arrangement. The structure of these plants is therefore widely different, and had we no experience of their natures we might infer from their organisms only that they are not suited to the same circumstances, and that they require different situations to flourish in.

The turnip has but few roots to absorb moisture and inorganic matter, it therefore demands to be placed in a suitable soil, in a moist situation. The potato has many roots and numerous absorbents, and it can thrive where the turnip would languish and

die. The difference observable between the two plants, so far as the roots are concerned, is, that the turnip can only collect the moisture immediately in contact with the bulbs, while the potato can collect it from a circle some two feet in diameter if necessary. And this difference extends beyond the mere space each commands, for it also extends to the manner in which the respective areas are covered by the roots and absorbents of the plants as well. In the potato, the ground is covered like a net-work by the main and lateral fibres and their numerous absorbents; while in the turnip the whole amount of roots seldom exceeds some few inches of straight fibres, and the absorbents some 58 or 60 in number. A turnip contains more water than a potato, the average of the turnip being about 90 per cent., while that of the potato in healthy seasons is full 20 per cent. less. The cuticle of the turnip is also about 70 or 80 times the thickness of the potato; so that the plants and their products are widely different from each other. Place the potato with its thousand of spongioles in the midst of moisture, and a turnip with its some 58 or 60, and the latter will flourish, while the former will overload itself and die of repletion. This may be proved by placing the two in a situation where the roots are constantly surrounded by moisture, and it will be seen that although the potato apparently flourishes for a time, yet it becomes so surcharged with water that it ceases to elaborate and dies. And this must necessarily be so; for if the roots absorb more water than the leaves need for the elaboration of the products, the prepared sap becomes weakened and vitiated, and soon ceases to have those properties which constitute its vitality; and thus the whole functions of the plant become deranged, and if the cause which produced this derangement continue, the circulation of the plant ceases, and it dies. The various parts of a plant are relatively proportioned to each other, according to the nature and character of the plant itself and the products it is destined to form. The extent of roots and number of spongioles are, therefore, in strict relation to the surface and power of the leaves, and it is the office of the former to supply water and earthy salts, to enable the latter to decompose the carbonic acid absorbed by them from the atmosphere for the formation of its products. Now, if the spongiole absorb too much moisture by any adventitious circumstance, and the leaves cannot exhale the surplus, the water fills the cell and weakens the powers of the plant, and thus prevents the absorption of carbonic acid and the consequent assimilation of carbon. If, on the other hand, too little water be absorbed, or none at all, the secretions of the plant are more slowly performed in the first instance, and totally stopped in the second. The power of the roots then being in the ratio of that of the leaves, every class of vegetables de-

mands certain conditions to enable its organism to healthily perform their functions. The potato is a striking instance of this; its roots have a great absorbing power, and its leaves a low exhaling one; and if the structure of a vegetable ever addressed us in plain language as to what the plant needed in its cultivation, that structure is the organism of the potato plant. Its thousands of absorbents teach us that they have a power to gather water from an almost arid soil, and its products that such a situation best suits them; we may therefore conclude that the potato plant is constructed for a dry soil rather than a wet one.

11. *Nature and Cause of the Disease.*

The nature of the disease is clearly that of putrefaction; and so satisfactory are the proofs on this head, that I apprehend no doubt can arise on the subject. The results of the microscopical and chemical examinations are in unison with each other; the former shows the destruction of the vessels, the latter that putrefaction arises from their decomposition. The vessels are azotised matter, and we have thus clear evidence that the vessels are broken up by putrefaction. So far, then, as the nature of the disease is concerned, all is clear; and could the cause be as easily arrived at, the subject would be simplified and brought within a small compass. But it is otherwise, for the cause is complicated and cannot therefore be so summarily dealt with. This complication arises partly from the nature of the apparent cause, and partly from the difficulty in proving a cause. For all our proofs of a cause are necessarily imperfect, ending as they always do in an effect of some other cause. But notwithstanding this difficulty, I apprehend it will be sufficient to treat the proximate cause as the real one, disregarding all other influences as to how that cause became active; and I shall therefore treat the apparent as the active power or influence, regardless of other considerations.

From the evidence which precedes this, I shall now draw such inferences as will, I trust, throw some light upon the cause of the disease we are considering of. These inferences I shall arrange numerically, so that we may consider them in a regular order, and enlarge upon them, if necessary, hereafter. In accordance with this plan, I observe—

1st. That the season was unusually cold and wet, and marked by a continued absence of sun.

2ndly. That the disease was more fatal on heavy wet lands than on light dry lands; and generally more so on wet soils than on dry soils.

3rdly. That exhalation and evaporation was at a low point during the months of July and August.

4thly. That fungi are the effect and not the cause of disease.

5thly. That it was a putrefactive disease, caused by excessive moisture, absence of the solar rays, want of exhalation from the plant and evaporation from the earth.

The three first observations approach more to the character of facts, as they are founded on the recorded testimony of the great mass of observers, and are generally admitted to be occurrences that happened during the season; I shall therefore apply myself more particularly to the two last, as it is in these we must look for the cause.

The early crops suffered less than the late ones, as a general rule; and the earlier planted of these less than those of the later planted. The plants generally throve until about the middle of June, when cold and wet set in; this state of things continued until about August, when the foliage of the plant appeared injured, and it was after that pretty generally observed that the crops were unhealthy. At the time that the most unfavourable weather appeared the late plants were in full work, the tubers being then forming. Now, we have seen that a plant cannot elaborate its products without the direct action of the sun's rays; and we have further seen that when the vital principle ceases its action, even temporarily, that a chemical one commences; and that this commences by an oxidation of the carbon and a liberation of carbonic acid, and, if this action continue, ammonia is formed.

What is the effect of this? If ammonia be formed in a plant like the potato, which in its normal state is acid, we have not only a subversion of the condition of the juices, but we have also an agent that dissolves the vessels of the plant, and destroys its organism. Here there is an agent equal to effect all that we have seen in the disease of the last season. But although we have thus briefly arrived at this change, it is a work of time in the plant, and necessarily involves many phases.

1st. We have absence of sun—cold, wet, and want of exhalation.

2nd. Formation and disengagement of carbonic acid.

3rd. Generation of ammonia.

4th. Putrescence.

During the time the plant was thus acted upon under the conditions of last season, many appearances presented themselves; for it was not the work of a moment, but a succession of minute actions, that gradually undermined the powers of the plant and destroyed its vitality.

When the sun withdrew its vivifying influence the plant was in the midst of water, and overpowered by it. Its exhalation was impeded, if not totally stopped, and it had an unusual degree of

cold to contend with as well. Now, what appearances would the plant, under such circumstances, present?

1st. The colour of the foliage would become darkened by the liberation of carbonic acid.

2ndly. The foliage of the plant would droop as its powers declined.

3rdly. Putrescence and fungi would appear.

The organs being the part attacked, putrescence would commence internally, and fungi might appear externally before the disease had made any outward show. I have satisfactorily ascertained that plants, in the absence of the sun, transpire carbonic acid, which is also authenticated by Saussure, Ingenhoutz, and others. A plant, therefore, in the shade and at night, undergoes a chemical action the reverse of that which vitality induces; and as the potato was placed in a condition during the last season to favour this action, it must have ensued, and the continuance of it would necessarily produce fatal results. The changes, however, that would take place in the juices of the plant would be gradual, and its powers would gently decline as the vitality of its juices and the disorganization of its vessels proceeded. The absence of the sun only, if other circumstances had been favourable to the plant, could not have produced putrefaction; because if the soil and air had been dry, exhalation would have so far solidified the juices as to prevent putrefaction, for without water this action cannot proceed.

Fungi have been considered the cause of the disease, and so also has the use of the tuber for seed; I shall therefore make a few remarks upon these heads before closing this section.

With regard to fungi being the cause, and not an effect, I shall refer the reader in the first place to section 7; and, with that fresh in our memories, proceed to relate some new matter, making such use of that in section 7 as may be suited to our present purpose.

I selected an apparently healthy potato plant, the top of which I cut off and immersed the stem of it in a vessel of common water, cemented to an ordinary table plate. I covered the plate with lime water, and the plant with a glass receiver. The glass receiver I cemented with Venice turpentine to the plate, and in this state I left it in the shade for about four weeks, and observed the changes it underwent; which were as follows:—

1st. The colour of the leaves changed to a deep but clear green; this remained for about ten days.

2ndly. The lower leaves became gradually brown and drooped.

3rdly. At the end of three weeks the whole of the leaves, except at the apex and stem, also were reddish-brown, and an abundance of fungi was now apparent.

The upper leaves retained their colour better than the lower, for at this period the lower leaves were dead, and a weeping and exudation was observable at the leaf-stalks. At the end of the fourth week I removed the shade and examined the external fungi, and stem and leaves also. The external fungus was the botritis, and it had spread over all parts of the stem and leaves. I dissected the stem and found an abundance of boleti and radiated fungi in the cellular tissue of the medulla, but could detect no trace of the botritis internally, or animalcule of any kind, putrescence having hardly set in. Now, in this case we have the leaves and stem of a plant apparently healthy generating fungi, or at all events rendering them sensible to us. Had this plant been growing in a proper soil and atmosphere would fungi have appeared? I answer no; because I had the fellow plant with several others still growing healthily without any appearance of fungi. From whence, then, came the fungi if we repudiate equivocal generation? We have found the seed of the botritis in the earth, and we now find an apparent generation of them, with that of other fungi as well; and we further find that they appear according to their character in certain kinds of matter, having regard to the state or condition of the matter they appear in. This question of apparent generation can only be answered by supposing that the germs of the various fungi existed in the plant, and that they act only when its vitality ceases. And thus being ever present they are ready to begin their duties when the condition of matter in which they appear is fitted for them; hence their appearance in certain states of matter. This view is more in accordance with the facts than any other, for we have seen that the various kinds are readily generated, and therefore we must either suppose their germs present or adopt the doctrine of equivocal generation. The precise view we take is, however, of little moment, seeing that the facts are always consistent with each other; and as these facts sufficiently bespeak the nature of fungi, and inform us that they are secret and solitary in their habits, and that they cannot bear the light of the sun, we may infer that they have no power to destroy healthful vegetation, seeing they can only act conditionally, and consequently that they are not the cause but an effect of the disease.

With regard to the use of the tubers for seed as being the cause of the disease, I would observe that the plants grown from seed were as much diseased as those grown from tubers; but were this fact not so, it is incorrect to view the tuber as a part of the plant, as if it were a mere slip or cutting grafted on a foreign stock; and thus suppose that its powers decline as the parent from which it sprung grows old.

The tuber contains distinct germs, and these germs are as much

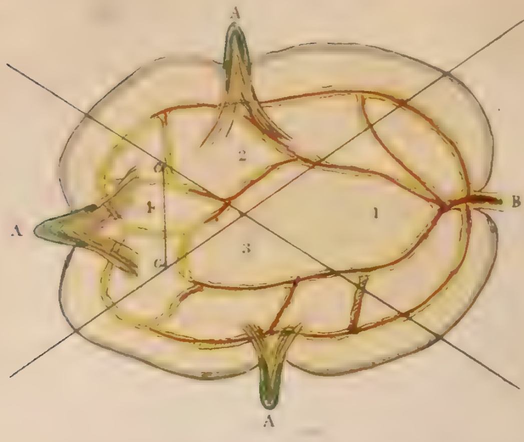
new beings as those of the seed; for the seed of the plant contains the embryo organs or vessels precisely as we find them in the tuber. And this indeed must be the case with all seeds, or they would have no vitality; consequently the tuber is as much seed as distinct * and independent germs can make it, and therefore not to be viewed as a slip or cutting whose duration of being is bounded by its parent's term of life.

But although the tuber is truly a seed-vessel that contains the germs of future plants, and cannot therefore grow old, and its powers decline by reason of the parent's age, yet its continued use may, notwithstanding, be the source of disease.

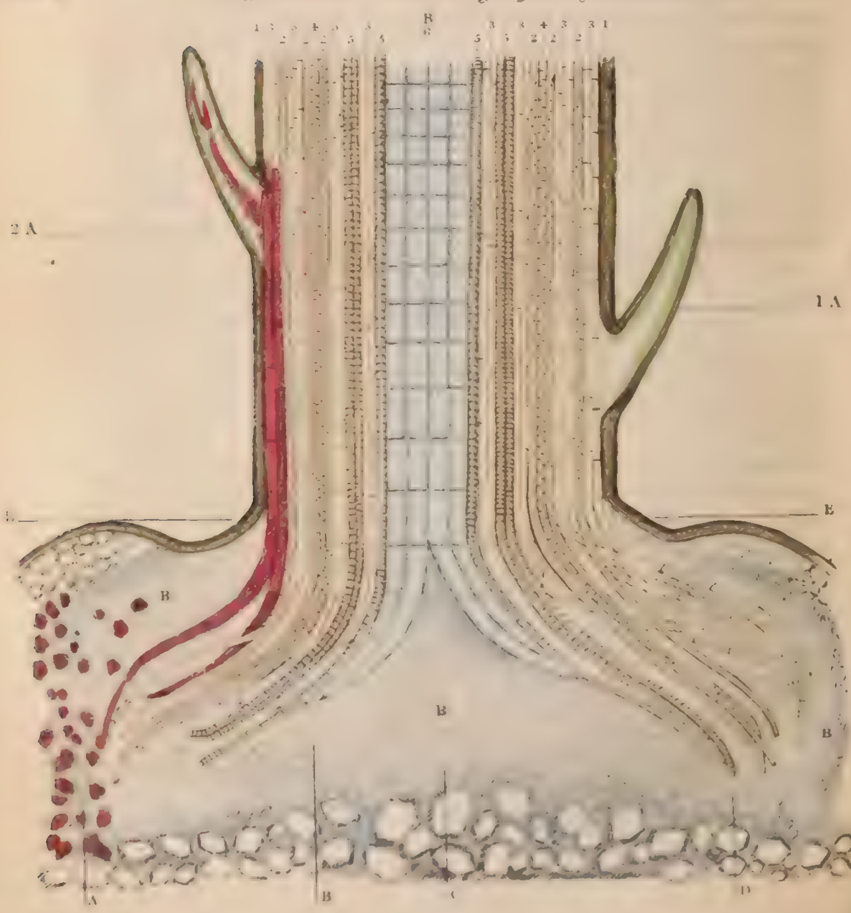
All plants, by whatever means propagated, are produced from germs containing the whole organism of the plant; and this relates as much to slips, cuttings, and buds, as it does to seed. For although we know nothing of the abstract principle of life, and cannot therefore say what constitutes its vitality, yet we know by observation how it manifests itself, and that a plant cannot healthily perform its functions unless its whole organism is perfect. We also know that a plant, however propagated, is formed by an elongation of the whole of the vessels, which are moulded into a form peculiar to the individual in which they exist, and that the integrity of the vessels is closely connected with the vitality of the plant itself. Now, if a tuber contain diseased germs, and if these germs vegetate, the plants they produce will be more or less diseased, according as the germs from which they sprung were affected; consequently a diseased tuber may generate diseased plants. Plate 6 represents a diseased germ, and shows how the disease may be communicated. The crimson spots A represent the disease in the channel of the germ B; and stolon 2 A shows how the disease may affect it by its passage through the vascular system 3. Stolon 1 A is free from disease notwithstanding it is the offspring of the same germ as that of 2 A. The same germ may, therefore, generate sound and diseased stolons, and hence sound and diseased tubers. This arises from the locality of the disease, and the nature of the circulation in the formation of the stolons and stems, which latter has been described under sect. 2 and 3. If from the same germ sound and diseased tubers may spring, it will be readily conceived that different germs in the same tuber may produce the same effect; and Plate 2 shows how this may be accomplished. That plate represents a longitudinal section of a tuber divided by two diametrical lines; B 1 is the stolen, A 2, A 3, and A 4, are portions of the tuber containing the germs A; the yellow lines from stolon B show the course of the vessels, the crimson the course and extent of disease. Section

* But seed produces varieties, tubers do not; *ergo*, more distinct.—A. H.

Pl.2. *Discased tuber. Longitudinal Section.*



Pl 6 *Longitudinal Section of young Plant.*



1 A and 3 A are diseased at the germs, and 4 A is diseased in the vessels of the section, but the germ itself is uncontaminated. 2 A and 3 A would, if they germinated, produce diseased plants; 4 A might produce a sound one, even if the whole section was used for seed; but if the affected part in 4 A was cut off at the diameter E C, thus getting rid of the apex of the angle containing the diseased portion of the section, a healthy plant might be depended upon as the effect of the germination of the gem. I do not connect the fact of a diseased germ generating a diseased plant with the disease of last season, but I consider it important to show that diseased tubers may generate diseased plants, because it is highly probable that disease to some extent may exist in the present season, in consequence of the tubers of the last being so much affected, and especially so should the weather prove unfavourable during the growth of the tubers.

Description of Drawings.

No. 1 is the cell of a transverse section of a diseased stem from a joint in this season's plant. The brown circular spots are radiated fungi; the insects, eel animalcule; and the brown parts marked B are a continuation of the diseased vessels of the cells. The parts marked A are portions of the adjoining cells.

No. 2 represents a longitudinal section of a diseased tuber; A A A are gems; B is the runner, or stolon. The yellow lines show the course of the vessels; the crimson, the extent of the disease.

No. 3 represents a young plant growing from the set; 1 is the set; 2 are the stolons; and 3 the roots.

No. 4 is a transverse section of a diseased tuber; 1 is the bark; 2 cuticle; 3 reservoir of empty cells, that are always found beneath the cuticle; 4 channels leading to the gems, and in which they are seated; 5 diseased; and 6 sound cells.

No. 5 represents the vessels of the gems and the termination of the roots; 1 is a germ, and 2 B are the spongiole of the roots; the part B being the mouths of the absorbents.

No. 6 is a longitudinal section of the stem of a young plant, and the part of the set from which it sprung; A, with crimson spots, represents a diseased part of the set or seed; B the channel of the gem; C cells of the set; D termination of the vessels of the gem in the channel of the set; E the crown of the set, and 1 A and 2 A stolons; 1 is the cuticle; 2 perforated vessels with hexagonal perforations; 3 vascular system, with diaphragms; 4 annular vessels; 5 spirals, and B 6 the cellular arrangement of the medulla.

No. 7 represents three kinds of fungi generated in diseased potatoes, plants, and other substances as well; 1 A are short white fibrous fungi, found in substances before putrefaction, and sometimes afterwards, when a moderately dry surface is formed for them; 1 B are round-headed boleti fungi; 3 is the same much magnified; 2 is radiated fungi, seen also in plate 1; 4 is radiated fungi, as seen growing from the vessels of the potato plant; 5 is a head of the boleti crushed, for the purpose of examining for seed; A is not seed, but air, enclosed in a film of water.

No. 8 is a cell found in a transverse section of a diseased stem, of this year's growth, at the base where it joins the set or seed. It is infested with the botritis or grape-like fungi.

XXIV.—*On the St. John's-Day Rye.* By W. P. Taunton, Barrister-at-Law.

Prize Essay.

Rye, called by Linnæus and the Latins, Secale; by the Italians, Secala; by the French, Seigle; by the Poles, Sieczka; names derived from the Celtic name Segal (Ainsworth); by the Germans, Schwarzer Rocken, is a plant of the order Triandria Digynia of Linnæus, and of the 2nd Class, Monocotyledoneæ, or Endogenæ, Order 210, Gramineæ, Section 8th, Triticeæ, of Jussieu. It is supposed by the authors of the 'Encyclopædia Metropolitana,' who do not, however, assign either reason or authority for their position, to have been a native of Crete. Loudon ('Hort. Britann.,' *voce* Secale) ascribes its origin to the Crimea. But it would be presumptuous at this day to assert that we know the native country of this or of any other of the Cereal Grasses. Its habits are those of a plant inured to the coldest regions; and we have the high authority of the President of the British Association for 1846, that Professor Von Middendorf (to whose works I have not as yet been able to obtain access) found crops of rye, more abundant than in his native Livonia, growing beyond the Yakutsk, on the surface of a frozen subsoil. This fact, and the concurrence of the earliest accounts which I have been able to trace, afford evidence that rye probably was introduced to Southern Europe from some northerly part of Asiatic Tartary. Although Moses speaks of a grain as being cultivated in Egypt 1491 years before the Christian era, which our translators of the Holy Bible have rendered by the name of rye (Exod. ix. 32); and although the prophet Isaiah, also, chap. xxviii. ver. 25, speaks of a plant which our translators have rendered rye, as being cultivated in Judea, yet I shall give some reasons below for believing that neither of these was the plant which we now know under the name of rye.

Rye does not appear to be mentioned by Aristotle, who most likely would have known it, had it been in his day cultivated in Crete. Dioscorides, as I shall endeavour to prove below, was unacquainted with rye. Neither Cato, Virgil, Columella, nor Varro speak of rye, whence we may infer that it was not among the crops usually cultivated in Italy in the times of those writers. Pliny, however, in his 18th book, chapter xl., ed. P. Harduin, p. 119, says, that in his time the Taurini, who were a nation of Cisalpine Gaul, residing at the foot of the Alps, in the country now called Piedmont, cultivated Secale, Rye; and he adds the very remarkable fact that they called it Asia. When we recollect that these Taurini, or Taurisci, as Polybius calls them, are acknowledged by Strabo, lib. iv. p. 286, line 16, to be of the Ligurian race, who were carried down the valley of the Danube

into Thrace in the stream of Gallic migration, having first moved from east to west in more northerly latitudes, and being of a cognate race, perhaps, to the renowned Asæ of Scandinavian mythology, we shall see a strong reason, in the singular name of Asia, given to this grain, to believe that it must have been borne from Asiatic Tartary by the restless rolling hordes of that great northern hive, through the northern, into the more southern parts of Europe.

Rye appears to have been in Pliny's time, as now, cultivated not alone for its grain, but also as fodder for cattle; for after saying, in book 18, chap. xxxix. p. 119, that rye and farrago (which he afterwards explains to be a thick sowing of tailing wheat mixed with vetches) required no other cultivation than a harrowing, indicating thereby that rye is best suited, as the fact is, to a light sandy soil, since a strong soil cannot be cultivated by a mere harrowing; and that in Africa, barley (which Père Harduin expounds to mean winter barley) is used for the same purpose, being sown together with a degenerate vetch, which Pliny calls Cracca, he adds, that all the articles which he has enumerated are destined for cattle food. Pliny further says that rye is the worst of grain, and only fit to repel famine; that it is productive, but is of a slender straw; that it is miserable for its blackness, but remarkable for its weight; that wheat is sometimes mixed with it to mitigate its bitterness; but that even so it is most unacceptable to the stomach: that it grows in dry soil, and makes a return of a hundred grains for one, and itself suffices for manure; thereby probably meaning, that, as it is a good forager, it will grow without dung. When we recollect that the means were familiar to Pliny of comparing rye with the splendid wheats of Italy,* we may not, perhaps, much wonder at his low appreciation of this homely though nutritive and useful grain. Its use at that time as a breadstuff was probably confined to the elevated and inclement regions, where the chilling blasts descending from the Alps rendered the culture of superior grain precarious and unprofitable. The author is not aware that the English farmer will agree with Pliny in considering that a rye crop positively improves the fertility of the soil whereon it grows, unless the proposition be confined to such crops of rye as are fed off by sheep in a green state, which may profitably be done in preparation for turnips.

I entertain doubts whether the rye mentioned in our version of the Old Testament was the plant which we now know by that

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* Pliny says, "There are many sorts of wheat, which different nations have created. [So that the crossing and obtaining varieties is not so novel an art as some may think.] But I can compare none to the Italian wheat in whiteness and weight, by which it is particularly distinguished."—*Plin.*, book 18, s. 12, l. 1, p. 106.

name. The translators of the Septuagint, who may reasonably be supposed to have had better opportunities of becoming acquainted with Egyptian husbandry than the learned divines who translated our Bible, render the word which occurs in Exod. ix. 32, by the Greek word Ολυρα, Olyra; and they have translated the word, where it occurs in Isaiah, by the name of Zea. Herodotus, in his 2nd book, ed. R. Stephens, p. 65, says, "Other nations live on wheat and barley, but among the Egyptians it is the greatest disgrace to a man to make his diet on these grains; but they make their bread of Olyra, which other people call Zea." It is not probable that those who coveted to live on "better bread," as Sancho says, "than is made of wheat," should have contented themselves with black rye-bread. Zea is the name which as well ancient as mediæval and modern botanical writers have applied to designate Spelt, Zea Spelta, of which, however, there is more than one variety. Among the numerous synonyms for rye, which the industry of Steudel has collected, no writer has used Zea as synonymous with Secale or Rye. Dioscorides, book 2, chap. 84, says that Olyra is of the same genus as Zea, Spelt, but is somewhat less nourishing. One Marcellus, a commentator on him, had translated Olyra into Rye; but Matthiolus, in Dioscor., p. 399, with apparent justice denies that Olyra was Rye; for he cites Galen as saying that the seed of the Olyra, like that of barley and oats, requires to be stripped of its integuments (decorticated, is his expression) before it could be used; whereas, as Matthiolus observes, rye, like wheat, falls naked out of the chaff. Galen also remarks that the colour of barley and Olyra is white, and the colour of wheat yellowish; whereas, as Pliny remarks, rye, Secale, is 'nigritia triste,' dismally black, as we all know it to be. Galen also interprets Olyra to mean Zea, where the term occurs in Hippocrates, as Robert Stephens testifies ('Thesaur.' tom. 4, 1558, *voce* Ολυρα). And Pliny, in his 8th book, chap. 10, says that Olyra is called in Italy Arinca, and in p. 111, that the sweetest possible bread is made of it; which surely, if intended to be spoken of rye, is inconsistent with what he has in the 18th book said of it, that its bitterness makes it most unacceptable to the stomach. Pliny also describes the Arinca, in his 18th book, p. 109, as being the especial produce of Gaul, but abundant in Italy, whereas he had already confined the cultivation of rye to the roots of the Alps: he describes the Arinca as being stouter than wheat, with a larger and heavier ear, which is wholly inapplicable to the slender straw by which he has above characterized rye. He says that the Arinca is with difficulty beaten out of the chaff in Greece; and that for this reason Homer (in the last line but one of the 8th book of the Iliad) mentions it as being served up to horses along with barley. The two last-mentioned qualities exactly apply to Spelt, for it makes

the finest bread in the world, and the grain must be first passed through a coarsely-set mill to disengage the grain from the glumes, before the grain can be put into the mill which is to reduce it to flour, for no flail can get out the grain. Further, Pliny says that the Olyra is peculiar to Egypt, Syria, Cilicia, Asia, and Greece, which certainly cannot be predicated of rye; and Matthiolus, in the 16th century, laments that the Olyra was then nowhere cultivated in Italy. The circumstance that rye is found to thrive in the coldest regions, strengthens the doubt whether the Olyra grown in the hot plains of Egypt, and the Zea cultivated in Palestine, were either of them rye.

There are several plants which botanical writers have at various times arranged as species of the genus Rye, but most of them are now placed under the genus Triticum or that of Agropyrum. There is a rye called perennial rye, which, according to Messrs. Lawson, the erudite authors of the 'Agriculturist's Manual' (p. 33), who have let nothing escape their notice, is a variety of the Secale fragile mentioned below. This plant the author has heretofore had in his experiment-ground, and has thought, from its precocious habit, that it deserved attention, as promising early feed; nor did he find that it was backward or penurious in ripening its seed; but in effecting a change of residence, the plant was neglected and lost, and the author has nothing further to report on it, except to recommend it to the notice of other experimental farmers. The species Secale fragile, said by Loudon to have been introduced about 1816 from Tauria, and Secale Orientale, a biennial, introduced from the Levant in 1807, appear to be still retained as species under the denomination of rye. But with these the author is not acquainted. For thirty years past has the author been vehemently desirous to obtain the rye of Astracan, reported by some writers to be the most beautiful grain that grows in the world, but all his endeavours have been fruitless; nor has he even been successful in ascertaining whether it be a real rye, and, if so, whether it be a species, or only a fine variety of Secale cereale; or whether it be, as some have surmised, merely the Polish wheat, Triticum Polonicum, a very remarkable and beautiful grain, which the writer has heretofore raised and admired. He therefore proceeds to treat of the Secale cereale, of which species there are several varieties:—1st. A spring rye, Secale cereale vernum. This the intelligent author of 'Le Bon Jardinier' for 1844 describes as having a stalk less long and more slender than that of the autumnal rye—a grain rather smaller, but heavy and excellent in quality; and says that the cultivation of this cereal has much spread in France within a few years past, and that it is sown in March. M. Vilmorin obtained from Germany a variety thereof, under the name of Great

Spring Rye, which was taller and had longer ears, and was a little later than that which is usually cultivated in France. After an intensely dry summer, 1818, when all green-meat was exhausted, and all verdure burnt up, the author inquired of that intelligent and philosophic agriculturist, M. Vilmorin, what crop he could sow which should most quickly yield some green-food before winter; when M. Vilmorin informed him that the spring rye was, of all the cereals which he then (twenty-seven years ago) knew, the most rapid in growth, and the most likely to afford a ready supply to the starving cattle. Probably he would now give the palm to the Moha, or Panicum Germanicum. Varley, a well-informed agriculturist, who wrote about 1777, speaks of the spring-rye as being then in cultivation; but the author is not aware that it is generally grown in this island, at least not in the southern part of it, to which his observation has been confined.

There is another variety, which seems to be intermediate between the spring-rye and the winter variety, namely, the Roman rye, or Seigle de Rome, of which the author of 'Le Bon Jardinier' for 1846, tom. i. p. 537, speaks in the following terms:—

"*Seigle de Rome.*—We owe this interesting variety to M. the Marquis Doncien de Chaffardon, whose son brought it from the environs of Rome some years since. It is particularly distinguished from other varieties by its light colour, and, above all, by the great size of its grain. In the autumnal sowings which we have hitherto made of it, the Roman rye has completely borne the winter, and has remained a fuller plant than other lots of rye sown by its side for comparison. In our spring sowings it has freely run up to seed, and even for the most part in good season. But, as an agricultural variety, it will require to be followed up for some years to come, for it to acquire that uniformity of vegetation and of character which distinguishes samples for a long time appropriated to a careful cultivation. It is only by a judicious and attentive choice of seeds that we can reach the result which we are pursuing, and at which we hope shortly to arrive. It will be always desirable that some amateurs shall come forward to second us in this interesting labour; and, in thus multiplying experiments, in the same proportion increase the chances of success."

To the untiring kindness of Messrs. Vilmorin the author owes the receipt of a portion of the Roman rye, as a present from those kind friends. Of this he intends to sow a part in the present autumn, and to reserve the residue for a spring sowing; but the limits of the period of time within which he is called on to close this paper, preclude him from having any observations to offer on the result of the trial. Should the variety prove of important value, he will hereafter communicate his remarks thereon to the Society.

The Secale hybernum, or common winter rye, is the variety most generally cultivated in England. It formerly constituted a

large proportion of the food of the English peasantry, particularly in the north, as it still does in the northern parts of Europe.

The author is not aware of the time when rye was first introduced into Great Britain. But it appears by Spelman's Glossary, title 'Firma,' who mentions rents reserved in rye at a very early period of our history, to have been long established in this country; Ray, in 1660, and Worlidge, some years earlier, enumerate it among the plants then currently cultivated in Great Britain, and the latter assigns to it the due rank as a bread-stuff, next to wheat. But in this island it had been, even before the recommendation of it published in the Society's Journal, vol. ii. p. 217, and is now, principally cultivated to furnish early spring-feed for ewes and lambs, for milch-cows, and to be cut green, after it has thrown up its culm, for soiling horses in the stable. For the latter purpose, however, the common sort is but imperfectly fitted; for in a very few days after it has put forth its culm, it becomes hard and sticky, and is rejected by the animals, and can no longer, without great waste, be applied to the desired purpose. The same variety is also used by unskilful persons to sow amongst winter tares or vetches, in order to support them, that they may not, by trailing on the ground, exclude the light and air, and become yellow, and lose their lower foliage. But it is ill suited to this end, because it grows so much faster than the vetches, that when the vetches are cut in blossom, the rye is become hard, and has ceased to be eatable, consequently is wasted. Moreover, it grows so much faster than the vetches, that it overtops, and if the proportion of rye be large, it by reason thereof shades and injures them. The proper grain to use for supporting winter vetches is wheat, and for this purpose the sturdiest varieties of wheat are the best. By a beautiful adaptation of the means to the end, wheat grows exactly as fast as the vetches do, and no faster, and has exactly the degree of stiffness requisite to support them; and when they are to be consumed, the whole mass is eatable together, the wheat being the most nutritious and valuable part thereof. It is hoped this digression may be excused, for the sake of the useful and satisfactory practice which it inculcates.

A custom long obtained in this country, as well as in others, of sowing wheat and rye together, which was called meslin or maslin, a Norman name signifying mixed corn, which seems to bespeak the antiquity of the custom; it is called by the French *meteil.* But this miscellany must have been attended with the inconvenience of the several parts of the crop ripening at an interval of many days; and, where the land was good enough to bear the wheat in perfection, we may surmise that it would have been more profitable to have raised an entire crop of wheat than to have spoiled the sample by the admixture of rye. Worlidge condemns

the practice. The bread made of this mixture combined, in a degree, the good qualities of both grains, but they might with ease have been mixed for the mill, although grown separately. It is many years since the author has seen a field of maslin in the South of England.

In the countries where rye-bread is still in use, as in Germany, this food is accounted to be slower of digestion, and to contribute more to keep up the muscular strength, than wheaten bread; and accordingly, the labourers prefer it in harvest-work and other severe labour. Next to wheat, it certainly is the most nutritive material for bread. It is also an excellent grain for rearing or for fattening all sorts of stock. In Belgium and Germany oxen are fattened with a compound of rye; and it is sometimes to be had in this country more cheaply than barley, weight for weight. The author has had signal success in rearing calves with a mixture of skim-milk and rye-meal, with a small proportion of the gold of pleasure ground up with it.

The author of 'Le Bon Jardinier' says that "a large and very beautiful variety of rye was communicated to him by M. Moll, Professor of Agriculture in the Conservatory of Arts and Trades, under the name of Seigle multicaule de Russie, or many-stalked Russian rye, a name which," he says, "it was necessary to modify, to avoid confusion; the term multicaule having been appropriated to St. John's-day rye; and because, moreover, this application of the name was not correct. In effect, this rye of M. Moll differed entirely from the St. John's-day rye (after mentioned). Its leaf was more broad, more straight? (*dressée*), of a more tender green, it was somewhat less late, and its grain was at once more abundant, more large, and of better quality. It did not tiller out more than the common rye of the French, to which it approached far more nearly than to the St. John's-day rye, but its produce in straw and in grain made it an interesting variety, and one which deserved to be followed up." The author of this essay has had this variety in cultivation for several years, and his observations on it confirm, in every respect, the character here given of it by M. Vilmorin, from whom the author received it, and who apparently was the author of the article above quoted. It is a very large, beautiful, and productive variety; the culm is longer eatable than our English rye, but, as a green fodder, is by no means equal, in the opinion of the author, to the St. John's-day rye.

The same ingenious experimentalist speaks also of a very fine variety called the rye of Vierlande, conspicuous for its large and beautiful grain. Of this the author has made no trial, the grain of rye not having been his object.

M. Vilmorin kindly communicated to the author another variety under the name of Seigle grand du Nord, Great Northern

rye, the culture of which the author pursued to some extent. He found it afforded a lofty and stiff straw, and a large, handsome, and heavy grain, but though sown in summer, it did not tiller out more than our common English rye; wherefore, seeing that it did not further his object of obtaining abundance of green-meat, he abandoned the cultivation of it. It very nearly resembled the large Tyrolese rye hereinafter mentioned.

Römer and Schultes, in their edition of Linnæus, advert to a variety of rye called Compositum, which name seems to indicate that the spike grows clustered like Composite, or Smyrna, otherwise Egyptian wheat; with this variety the author is unacquainted.

The author obtained in the autumn of 1845, from Mr. Thomas Cooper, of Ardleigh Wick, near Colchester, Essex, an extremely valuable variety of rye, which Mr. Cooper called his Early broad-leaved rye. This, on the 3rd of September, 1845, the author drilled with pulverized manure on a piece of good, strong wheat-loam, which had been folded with sheep eating off winter vetches thereon, and had been repeatedly ploughed, dragged, harrowed, and couched, and was brought to a beautiful and fine tilth. On the same day, on similar and similarly prepared adjacent land, he drilled, 2ndly, common rye; 3rdly, Russian rye; and 4thly, St. John's-day rye, that he might have an opportunity to compare the different varieties with each other, when all were sown under similar circumstances. From the observations detailed below respecting Cooper's early broad-leaved rye, the author has inferred that this is the variety referred to by an eminent Essex farmer, Mr. Baker, of Writtle, in the paper wherewith he has favoured the Society in the sixth volume of their Journal, p. 179.

But the variety of which it is the author's duty and intention principally to treat, and which, as he conceives, is the most valuable of all to the English farmer, is the Secale cereale multicaule, called by the French Seigle multicaule, or Seigle de la St. Jean, the St. John's-day rye; touching which he finds the following testimonials. The late Rev. W. L. Rham, in his 'Dictionary of the Farm,' p. 444, says:—

"There is a variety of rye mentioned by continental authors by the name of Seigle de la St. Jean, or St. John's-day rye, because it grows so rapidly, that if sown about St. John's day (24th of June), it will be fit to mow by the middle of September, and, in favourable seasons, may be fed off again in November, without preventing its giving ample feed in spring, and a good crop of grain at the next harvest. It might be advantageous to introduce this variety into England, if it be not already known. There is no doubt that there are varieties of the same kind of plants, which have a much more vigorous vegetation than those commonly cultivated; and the introduction of them where they are not

known, is an important benefit to agriculture. The celebrated agriculturist Du Hamel du Monceau mentions an individual who had obtained from one sowing five abundant cuts of green rye for cattle in two years. If any green plant is cut down before the fructification is completed, it will in general throw out fresh stems; and in very rich soils its blossoming may thus be continually retarded, until the roots become too weak to force successive stems."

The variety quoted by Mr. Rham must either be a different variety, or else must be cultivated in a far superior soil and climate to those which are known to the author. The introduction of the St. John's-day rye into England is due, so far as is known to the author of these remarks, to the late John Shute Duncan, Esq., LL.D., a person whose long life was passed in the untiring exercise of every patriotic, charitable, useful, and friendly act that could adorn human nature, or add to the happiness or gratification of his fellow-creatures. That valued friend, knowing the fondness of the author for agricultural experiments, near thirty years since obtained from M. Vilmorin, No. 30, Quai de la Megisserie, dit de la Feraille, Paris, amongst many other new and valuable varieties of plants, which the writer, under his auspices, introduced into England, as the Georgian oat, the winter bean, and the double-bearing saintfoin (now lately communicated to the Royal Agricultural Society), about a pint of the seed of the St. John's-day rye, and presented them to the author. From this small beginning the author, in the four following years, raised a stock sufficient to crop many acres, which he used both for stable-food and for sheep-feed. But a change of residence occasioning him to relinquish farming for many years, those to whom he disposed of his stock of this grain neglected to preserve it. When the author again resumed farming operations, one of his earliest cares was again to import from Messrs. Vilmorin and Co. a supply of this useful seed.

It is worthy of remark, that those admirable farmers the Tuscans, from whom, according to the testimony of Messrs. Lawson (Agriculturist's Manual, p. 32), M. Vilmorin obtained his first sample of St. John's-day rye, "sow," as related by M. J. C. L. Simondi, the learned and judicious author of the 'Tableau de l'Agriculture Toscane,' p. 60, "a great deal of rye, or rather," as he says, "of maslin. They sow it in the most fertile soils, and in the most meagre. The first, they say, are too rich for wheat, the latter too poor. All the fields which the inhabitants of the hill district of Tuscany (La Colline) possess at the entrance of the plains, are in general sown with rye, as well as their gardens, which the gardener wishes to rest, or rather to impoverish, which he does every three or four years."

The soil most suitable for the culture of the St. John's-day, as

well as of all other rye, unquestionably is that which contains a large proportion of siliceous matter. "The true rye-lands," says M. Simondi, "and in which it can alone succeed, are the sandy soils, and there are (in Tuscany) many such in the neighbourhood of the rivers. Good farmers have for some time past compelled themselves to exclude rye from all other soils." A considerable mixture of argil, however, is not inconsistent with good rye crops: a very stiff clay is less favourable, and a mere calcareous soil still less agrees with this grain. Crops of rye on the chalk downs are not a fair specimen of the capabilities of the plant. In a deep rich siliceous sandy soil, well manured, the author has once raised, on a limited breadth, a produce after the rate of 40 bushels of grain, and 11 London loads of straw, to the acre. He has found it a most abundant and valuable food for sheep, and an excellent soiling crop; insomuch that he has habitually made it his chief dependence for all his stock in stable and stall, from the time of the year when he can first begin to cut it without extravagance, to the time when it ceases to be eatable, comprehending, in those years when he has had an ample breadth of it, a period of from 30 to 50 days. In 1844 it was first cut by him on May 4, and continued to be eaten until June 7, when it was finished. In 1845, it was first cut for the stock some day about the middle of May, and continued to be eaten by the horses until the 4th of July. In 1846, it was first cut on the 5th of May, and the last of it on the second day of June; at which time the Racer vetches being in full blossom, and amply fit to cut for the use of the stable and cowhouse, and to succeed in the place of the St. John's-day rye, he was compelled to begin eating them, and thereby was enabled to avail himself of the opportunity to convert a part of his rye-crop to the purpose of dry fodder, and also to preserve a larger than usual quantity thereof for seed.

The author's experience of the value of this plant for sheep-feed has been more limited than he could have wished during this his second period of its cultivation; for, partly through the desire to follow up his turnip-sowing, as long as turnips were worth sowing, and his reluctance afterwards to sow this rye at a season when he knew he could not do justice to it; partly from the large portion eaten by 12 horses, 4 cows, and 20 or 30 pigs for six or seven weeks; partly from the necessity of saving a portion for seed for himself, and from the desire of imparting portions to improving agriculturists, he has rarely, and indeed in one year only, had any breadth to bestow on his sheep; which, in that year however, throve well on it; and he therefore is unable to give any specific details as to the number of sheep that an acre would carry for any definite time, and must confine himself, for the rest, to his recollections of 25 years since, which have left on his mind

a very favourable impression of its utility as a food for ewes and lambs.

Living in a country where water-meadows are in great perfection, he challenges any occupier of water-meadows, in 1848, to carry an equal quantity of stock on a limited breadth of the best watered or dry meadow, to that which the author will carry on a like breadth of St. John's-day rye, at any periods between the first day of January and the first day of May; the period for stocking one half of the ground to be chosen by the one party, the period for stocking the other half to be chosen by the other party.

In order, however, to obtain the full advantage of the productiveness of this crop, some conditions must be observed. In the first place, if the farmer wishes for a full crop of any bulky plant, he must not sow it on an impoverished soil, or he will be disappointed. And such would be the case with this. But if he will prepare his land with as reasonable a share of manure for this plant as he would for turnips or wheat, he will find a return not inferior in value to that which either of those plants will yield him in the south-western counties of England. And the supply comes in at a period when, of all times of the year, green-meat is the most difficult to attain; when the turnips are exhausted, or have run to seed, when the swedes are consumed, the hayricks shrunk, the horses tired of dry food, the cows requiring a moist food to sustain their milk, and the lambs clamorous for something juicy. Another condition is, that the cultivator must give the plant time enough to grow. The author cannot too strongly inculcate that, in order to obtain the true value of this plant, it is requisite to sow it about the time of the summer solstice; and that if you postpone the sowing until the latter end of summer or the autumn, you obtain a much inferior produce, and that the plant, in truth, is not then worth sowing. Many, thinking they have all the year before them, will not sow it early in summer, but defer the sowing to a later season, and are consequently disappointed in the produce, and condemn the plant as worthless. Some have expressed a fear that, if sown thus early, the rye would throw up its culms before the winter, and the crop be lost; but the author has never once seen a single plant of the genuine St. John's-day rye to spindle before the following spring. Some, hearing that it ought to be sown so early, think that no plant will repay so long an occupation of the ground, and that on this account it is not worth sowing. But such persons should consider that there are other plants which require, and will repay, an equally long occupation of the ground. On the elevated oolitic table-land called the Cotswold Hills, in Gloucestershire, the young wheat already come up, and the ripening wheat, not yet harvested, are currently to be seen growing side by side in ad-

jacent fields. The same doubtless occurs in other parts of England. The swede, if not carted off and stored, occupies the land for very nearly a twelvemonth; yet who will deny that wheat and swedes are worth cultivation? In the course of this paper some striking examples will be given of the difference between the produce of an early sown and a late sown crop of St. John's-day rye.

The mode of operation by which the St. John's-day rye becomes so productive, is its tendency to throw out extremely numerous branches from the same root; or, as it is expressed by farmers, to tiller out greatly; from which quality it has obtained its name of multicaule, or many-stalked rye. These branches are not all produced at the same time, but successively; and the season for their production is limited to the period during which the plant is not excited to throw up its culms; for after the culms have begun to rise, there is little or no addition made to their number. It is important, therefore, to the increase of the bulk of the crop, that the period between the germination of the seed and the rising of the culms should be protracted as long as possible. The longer it is, the more numerous will be the branches from a single root. This, therefore, is the cause of the marked advantage attendant upon sowing at midsummer. In consequence of this habit of tillering, a very small quantity of seed suffices, if it be early sown. I think that a bushel is sufficient to produce the maximum of grain upon an acre, if sown on good land at midsummer: the quantity of green-meat will probably be augmented by sowing a somewhat larger allowance of seed, especially if the land be at all subject to the wireworm, which feeds greedily on this rye, and which I have found to destroy an entire crop when the ground has been left hollow. Indeed, I consider abundant compression of the new-sown soil by Crosskill's clod-crusher, or, in its absence, by other heavy rollers, and by the treading of sheep, to be most efficacious, if not essential, to the success of this crop.

The author cannot agree with the statement of the writer quoted by Mr. Rham, that the St. John's-day rye is a fast-growing plant. On the contrary, he conceives, and has proved by experiment, that it is a slow-growing plant, and that herein lies one of its principal merits. A fast-growing plant would not retain its culms in a state sufficiently tender to be eatable for a period extending from thirty to fifty days. He has always been most successful with this crop in proportion as he has more nearly adhèred to the precept of sowing it at midsummer. It occupies the ground for nearly a year therefore; for, as to the proposition of harvesting it in May or June, the author certainly never found any crop of this variety ripe and fit to cut for seed before the beginning of July, and in some years not so early. Messrs. Lawson (p. 32)

testify that, grown beside common or winter rye, it was fully a fortnight longer in coming into ear, and ten days later in ripening. A considerable aid towards the obtaining the full value of the crop, whether for sheep-feed or for green stable-meat, will be found in abstaining, if possible, from cropping it until the spring; and this for two reasons. In the first place, it is well known to physiologists that the foliage of every plant has important functions to perform in increasing and strengthening the roots; and that if you rob the plant of its foliage, you detract from its power of bringing its produce to perfection. Some of the neighbours of the Rev. Professor Henslow asked him whether he approved of their practice of mowing their carrot-tops? to which he answered by another question, What was their object in so doing? Whether it was to reduce the size of the roots? for if such was their aim, they would thereby fully attain it. The same consequence attends cropping the rye. Mr. Baker observes (Journal, vol. vi. p. 181) that "rye must by no means be fed off with sheep, as it never comes well to the scythe afterwards." This proposition, of course, does not apply to such rye-crops as are sown for the exclusive purpose of sheep-pasture; but in that case the grower purposely consumes the crop in an early stage of growth, being content with the profit which he has then already achieved, in like manner as it may be good husbandry to kill a fat lamb. The copious covering which the foliage of a crop of St. John's-day rye gives to the soil during the parching winds of March and April, if shortly after eaten off by sheep, will leave the soil in a most rich and mellow tilth to receive a crop of swedes, carrots, mangold-wurzel, or turnips; but a further crop of rye from the same roots will render but an inferior return. The lamented George Sinclair (Hort. Woburn. Gram. p. 249) states, that he found that old plants of grass, when cut very close after the first shoots of spring had made their appearance, afforded about one-third less weight of produce, in the whole season, than those plants of the same species which were left uncut till the flowering culms began to appear; and he also found, on repeated trials, that cropping seedling grasses before they had produced flowers, had the effect of retarding and weakening the after-growth of the plants for that season very much. I believe there is no farmer who has been compelled by want to depasture a piece of seeds in early spring, who has not feelingly learned how insignificant the entire produce of that piece, in the whole year, has been rendered by that unthrifty operation. The case is the same with rye fed off; and it is to be noted that the autumnal feeding off the foliage is usually an uneconomical disposition of the crop. For the most part, feed in the autumn, before frost has commenced its depredations, or the sun wholly withdrawn its influence and vegetation

become dead, is abundant and of low value; while in the spring, in our climate, green food is excessively scarce and valuable. It would not be too much to say that the same weight of green-meat which in October or November would be worth 1*l.*, in the following March would be worth 3*l.* Now this rye-plant ought, still less than any other sort of herbage, to be sacrificed to autumnal pasturage, by reason of a distinguishing peculiarity which it possesses, and which remarkably contrasts with some other crops: *e. g.*, if you sow winter barley, you may observe that there are never, throughout the autumn and winter, above three or four healthy root-leaves at once existing on the plant. So fast as a fifth leaf makes its appearance, the first, and perhaps the second, turns yellow, and dies away—they have discharged their functions, and are gone: consequently there is little waste in repeatedly feeding off winter barley, at intervals of a few weeks, during the winter and early spring, for if the sheep did not consume the foliage, it would spontaneously perish; and to make winter barley a useful crop for this purpose, it is only necessary that there should be a considerable breadth of it in cultivation, for inasmuch as there is never a large quantity of herbage on it at any one time, if the space sown therewith be small, it is not worth while to remove a flock of sheep to it. In respect of sweetness and nutritive quality, winter barley is a very desirable food for sheep.

The St. John's-day rye, however, has a widely different habit. The root-leaves neither die away in the same degree as those of the barley, nor are materially injured by the frost; and so soon as the influence of the vernal sun returns to the earth, the young leaves, under the shelter of these old leaves, shoot up among them, and attain nearly the same height as their nurses, regardless of the north-easterly winds; and the mixture of the old and young leaves furnishes not only a more bulky, but a heartier and safer meal for a sheep than the tender young shoots alone would do, for the earliest shoots of almost every sort of herbage often have too aperient a quality; while, if there had been no old leaves remaining, but if these new leaves had to rise into the cold air from the naked ground, they would not at that time venture to put out a shoot. This crop realizes, in an eminent degree, the benefits contemplated by the late Arthur Young, in strongly recommending the farmer to preserve the old fog, or after-grass, of pasture fields, untouched through the winter, for the food of ewes and lambs in spring. You not only have the foliage you had in November, at a time when its specific value is doubled or trebled, but you have its bulk doubled also. There may, indeed, be cases when an early sowing, combined with very rich or highly manured ground, or a soil fully stocked with charlock, may pro-

duce such a mass of autumnal foliage that it would in a long winter rot on the ground. In such a case it might be necessary to mow or feed it before winter, but that is an extreme case.

You can only give the crop this long season, required for perfecting its growth, by means of sowing it early. It is possible that even by sowing it as late as Christmas a crop of grain may be obtained, but probably a poor one; and the same profusion of herbage must not be expected from such a late sowing as if it had been sown half a year sooner. If you sow a turnip at Michaelmas, you may possibly have a growth of puny leaves in the spring, but you will not have the noble bulb which you might have had if you had sown your turnips at Midsummer. In truth, the powers of reproducing from the same roots vary very materially in different plants—not in perennials only, as in the lucern, which will rise to flower three or four times in the year—in the double-bearing sainfoin, which will flower and ripen its seed twice in the year—and in the common red clover, which will currently flower twice; and, as in the summer of 1846, occasionally three times in the year—in the beautiful Hordeum bulbosum, which, if cut when in flower, raises its second crop of culms to perfection in the same summer—and, in the Italian rye-grass, which well ripens two crops of seed in the year, and if abundantly manured, as in Mr. Dickinson's case, produces many crops;—but also in what are often called biennials, among which, perhaps, the wheat predominates, for I have known an excellent farmer, who had a small farm and abundant manure from a fully-stocked yard and stable, to mow his wheat-crop for stable food currently twice, and in one instance thrice in the summer, and to ripen a crop of the grain of wheat in each case—in many, or most instances, a good crop—but his fields were like a hot-bed, and if he had not mowed them, the wheat would have been lodged and rotted on the ground. Wheat is, in truth, the most nutritive and the most productive,* though not the earliest, of all soiling crops; and those few fortunate persons who complain that their land is too rich for wheat, would, if they were to cultivate wheat thereon as a soiling crop, enjoy a most abundant and profitable return therefrom. But I do not believe that rye has the same exuberance of production, even under similar circumstances. I have often seen wheat lodged to a vast extent of acres. I cannot call to mind that I ever saw a crop of rye, either of my own or of others, lying lodged. The culm of rye, though often much taller than that of wheat, appears usually capable of sustaining and carrying on to perfection all the nutritive matter that the roots can throw up into it. This circumstance, if my observation (which may, however, arise from having been princi-

* Tritico, says Pliny, lib. 18, s. 21, nihil est fertilius.

pally conversant with poor land) is accurate as a general remark, seems to give an additional reason for not nipping the rye-crop in an imperfect state. Nevertheless, every cultivator's particular wants must be his practical guide, to prescribe to him whether he shall consume his crop when it is needed, or starve his cattle while he is bringing his crop to theoretical perfection.

I will briefly notice one other useful quality of this crop, when cultivated for soiling. If it has been sown on deeply-ploughed and friable ground, when the land comes to be ploughed up for turnips it will be found that the stubble of each plant has attached to it a huge tuft of long fibres, retaining a considerable quantity of fine mould entangled between the fibres. After dragging and harrowing, if these be carted off, they will furnish an immense supply of dry absorbent matter for the bases and liquid ingredients of manure heaps, or for bedding the yards. Indeed it would be, in some instances, impracticable to drill turnips on land without removing them, so that unless the farmer resorts to the barbarism of burning so large a mass of useful vegetable matter, he is compelled to prepare for an economical management of his next dung-heap, whether he will or no.

Inasmuch as the culture of this or any other grain cannot be perpetuated without setting by a certain portion of the crop to ripen for seed, it is worth while to look to the value of the straw. This, on good land, rises to the height of 6 or even 7 feet. Without adverting to the utility of straw of that length for thatching, and for making reed screens for garden use, in places where marsh-reeds are not easily to be had, it is to be noted that this long straw has its peculiar value for collar-makers, since one length of it suffices to go entirely round the deepest collar, even for the largest stallion; and the author has been in the habit of selling what he has raised at the comfortable price of 5*l*. per ton to his collar-maker for that purpose, which price, if a farmer can raise such straw after the rate of 11 London loads of straw to an acre, as the author has once done, may help to solace him for the hardship of devoting his land for a whole twelvemonth to the production of a single crop, and soften the burthens of rent and taxes.

A further good quality which I have witnessed in rye, and which, though not generally applicable, may in some instances serve the farmer to a valuable purpose, is, that rye is a plant peculiarly susceptible of being excited and increased by irrigation; while, from some appearances which I have noticed, I have reason to suspect that the wheat plant is injured, and even destroyed, by the same process.

It may perhaps be asked, since the St. John's-day rye has been partially known in this country near thirty years from its first

introduction, and since it is so useful a fodder, why has not the cultivation of it been more widely diffused? The answer is, that several causes have concurred to retard its progress. First, the slowness with which new articles of culture become known and adopted. For instance, it is now more than half a century since Dr. Lettsom introduced mangold-wurzel into England; but it is only within a very few years past that its transcendent utility has been acknowledged, and its use become general. It was nearly as long before the use of swedes was established. In the next place, from 1823 to 1840, a period of seventeen years, the author, to whose use it had been principally confined, discontinued farming, and so could not during that period contribute by his own act or example to diffuse its cultivation. In the next place, the grain of the St. John's-day rye is usually of a very poor, insignificant sample, and very small, and from this circumstance the seed is very liable to be foul, and become mixed with the obtrusive seeds of several Brome Grasses, Bromi, and Droke, Lolia, Arvense, and Temulentum, which are nearly of the same size with this rye. The difficulty of separating them from the corn is indeed so great, that on one occasion, when a neighbouring farmer had bought, and received, and paid for a portion of this grain for seed, he returned it, and solicited that he might have his money returned, under the belief that he had been supplied with only the tailing corn: it was, however, as clean as any which with much care had been prepared to be sown on the author's farm.

The gentleman to whom the author made over his stock of the St. John's-day rye in 1823, after two years' trial, threw it aside, having imbibed and avowed the persuasion that the rye degenerated into droke and lop grasses, Lolium temulentum, and L. arvense, Bromus secalinus, arvensis, mollis, &c. Touching this belief, when we see so talented a person as the author of the 'Vestiges of Creation' gravely quote, without reprobation, the statement of some German writer, whom he does not name,* that oats sown in the spring, and depastured through the summer and autumn, will in the succeeding spring produce a crop of rye, we ought not to treat with contempt a similar opinion held by any practical farmer. The wisest and most philosophic person † with whom the author ever had the honour and happiness to be acquainted, early in the author's life, inculcated the precept, never to pronounce the statement of any physical phenomenon to be

* The author has not had an opportunity of seeing the Vindication of that work, in which the German writer is said to be named. But Chambers's Miscellany, article "Curiosities of Vegetation," title "Transmutation of Plants," quotes Dr. Weissenborn, who states that oats sown in the latter end of June, and twice mown in the same summer, produce a crop of rye from the same crowns in the following summer.

† The Rev. Joseph Townsend, rector of Pewsey, Wilts.

impossible. More intimate researches into the wonders of nature almost daily prove that accounts of physical facts detailed by old writers and travellers, which the incredulity of our forefathers and our own sciolism had proscribed as false and impossible, are well supported by the truth; therefore the author will not venture to say that the transformation of oats to rye, or of rye to droke or lop, is impossible; but he will say, that no appearance which he has seen, during more than threescore years of not incurious attention to physical objects, does in the least degree induce him to believe that such a transformation ever has taken or ever will take place. On the other hand, he will state facts which are very likely to mislead an inattentive observer into this belief, and to generate an erroneous opinion that such a change or degeneracy does take place. The seed of Bromus mollis drops to the ground before rye is ripe, and grows freely. The seed of the St. John's rye is, for the most part, not larger than the seeds of droke (Lolium temulentum, and L. arvense, and of Bromus secalinus,—smooth rye-brome-grass); and no sieve which the author has ever been able to obtain will separate the bulk of the rye from these two seeds. The author has recently discovered that a very strong wind, applied through a good winnowing-machine, like Mr. Ground's, will separate a mass consisting of the tailing rye, droke, and lop together, from the head-rye; but this is the nearest advance he has made towards cleaning the seed, if ever it comes foul from the flail. Droke is the enemy most to be dreaded in strong soils, and the brome-grasses in light soils. Both of them increase in a much greater ratio than the rye. For example, taking a certain number of plants of droke, the author finds nine ears thereon, each ear containing 66 seeds, together about 600 seeds. He has found that the like number of plants of Bromus secalinus, grown among the St. John's rye, have brought to maturity 39 ears, together containing 2873 seeds; while from the like number of plants of St. John's-day rye the produce was 11 ears, containing 465 grains only;—so that, judging by this specimen, the droke may be taken to increase faster than the rye, nearly in the ratio of four to three, and the Bromus secalinus to increase faster than the rye, in the ratio nearly of six to one. If, therefore, in the seed first sown there were one seed of droke among twenty seeds of rye, and the entire produce were re-sown without getting the droke out of it, year after year, then, in the seed to be sown in the eleventh year the quantity of droke would exceed the quantity of rye by more than twenty per cent.; and if the Bromus secalinus were in the first sowing to bear the proportion of one seed of Brome to twenty of rye, and the whole produce were to be sown together without getting out any of the brome-seed, year after year, then, in the third year the brome would be nearly double of the rye, and in the fourth

year the seed to be sown would contain eleven times as much of brome as of rye. There is no need, therefore, to resort to an unheard of and unproved process of nature, the metamorphosis of one species of plant into another, in order to account for the exuberant growth of droke and brome grasses among crops, in preparation for which the farmer believed he had sown only rye; since a very moderate degree of slovenliness in the grower and thresher of the seed of the St. John's-day rye will account for the variation in the crop, without recurring to any preternatural or newly discovered powers. It is not *dignus vindice nodus.*

It will be seen, by the accompanying specimens of Lolium temulentum, Bromus secalinus, and St. John's-day rye, how little difference there is in size and specific gravity between the one seed and the other.

The writer is fully persuaded, and wishes strongly to inculcate, that the value of this fodder makes it worth the farmer's while to take the requisite pains for obtaining a clean sample of the seed of the St. John's-day rye, which may be thus effected:—Sow a small portion of land with it in drills, at eighteen inches or two feet asunder, hoe the crop carefully between the rows, and handweed the rows as often as it is necessary. Be not tempted by the beauty and apparent excellence of the intruders to preserve them till the harvest. After the rye is in blossom, there will be seen coming up among it the Bromus secalinus in numerous tufts, with so broad a blade, (much broader than that of the rye,) of so deep and beautiful a green colour, with culms so bulky and so juicy, that the cultivator is tempted to spare them, as more beautiful and valuable than the rye itself. Nor is the author disposed to affirm that this grass, which cattle eat freely among the rye, may not be worth cultivating in the alternate husbandry by itself, either for hay or soiling; but he is not aware that the experiment has been made. If made, this brome-grass would come in as a green crop, to succeed the St. John's-day rye. But suffice it here to say, this brome-grass is not the St. John's-day rye; and, whatever plant a good farmer cultivates, it is expedient that he should sow clean seed, in order to test truly the value of the subject. If it be not worth raising alone, and for its own sake, let him reject it, and grow something better.

On the 28th of May, 1846, the writer of these remarks having an acre and a half of St. John's-day rye then nearly in full blossom, and therefore, as he believed, at nearly its fullest bulk and excellence, caused one square rod of it to be mowed, and the produce to be weighed in its green state, when the weight was found to be 121 lbs. avoirdupois, being at the rate of 8 tons, 12 cwt. 3 quarters, and 12 lbs. of green-meat per acre. The same produce of one rod being, when dry, again weighed, was found still to weigh 40 lbs., being after the rate of 2½ tons per acre, which it

fully realized. Having reason to think that he had more than he could consume in a succulent state, he mowed, on May 27th, an acre and twenty rods of it, a very even crop, which, on the scale of the rod above mentioned to be weighed, must have yielded him about 3 tons 4 cwt. of dry fodder, and which rapidly dried; and, following the example detailed by the Earl of Essex in the Society's Journal, Vol. V. p. 622, he mixed it in the stack, as an absorbent for the juices of an abundant crop which he had of hop-clover, or nonesuch (Medicago lupulina), in a half-dried state, with apparent benefit to both sorts of produce.

An eminent London seedsman believing that he had obtained from the Tyrol a supply of St. John's-day rye, the writer procured from him a sack of it, in order to institute a comparison between that and his own. On the 19th day of September, 1845, being the earliest day on which he could obtain it, the writer drilled side by side on a light chalky soil (the only land he then had vacant for it), with pulverized mixed manure, this Tyrolese giant rye, some Russian rye, and some St. John's-day rye. The Tyrolese rye produced an excellent crop, regard being had to the quality of the land, with a large heavy grain, and tall straw, but the plant was deficient in tillering out, and consequently did not appear identical with the St. John's-day rye, nor its equal for the purpose of producing food for cattle. The Russian rye, which had rather the worst land of the three, was a fairly good crop, but not equal in the height of straw or in the size of the grain to the Tyrolese rye; the St. John's-day rye, sown on the same 19th of September, was the shortest in the straw, the meanest in the grain, and altogether the most unproductive of the three sorts: at the same time, this St. John's-day rye was in actual contact with another crop of St. John's-day rye, sown on the 12th day of July (three weeks later, indeed, than it ought to have been), on similar soil. The contrast between the two sowings was very conspicuous; that which was sown on the 12th of July being much thicker on the ground, much stronger in the straw, more than a foot higher, and much superior in the quality of the grain (for both were preserved for seed), than that which was sown 69 days later.

I will now revert to the experiment made with Cooper's rye, as above mentioned, In the months of January and February, 1846, Cooper's early rye exhibited a dense mass of foliage, and a richness of verdure, to which none of the other three varieties, sown on the same day, in the same field, were at all comparable. Indeed, if it had been then required, it might have been, without any imputations of waste, fed off by ewes and lambs in the month of February; and it may be doubted whether it would have been more profitable for sheep-feed at any subsequent time. In March the radical leaves of this variety had nearly all turned yellow and

died away, and the plant had evidently commenced the process of spindling, so that its value for sheep-feed had apparently begun to decline. On the 15th of April about one-fifth of the culms of Cooper's early rye disclosed the top of the ear, and the average height was two feet. The colour was dark and rich. The rye sown next to this was the common rye, which now exhibited a most meagre and miserable appearance, there being very few leaves from one root, and those, too, of a light and sickly colour, and not above 5 or 6 inches in length; next beyond this, came the Russian rye, with a fine, broad, dark-coloured, and healthy blade, but, as yet, not spindling. The fourth was the St. John's rye, healthy in appearance, but the blade less broad and less forward than that of the Russian rye.

April 27.—The St. John's rye, sown on the 21st of June, was now about 22 inches in height, but it did not as yet disclose any ears. And another portion of it, which was sown on July 7th, was little behind it; the latter ground having been rather better manured, and more finely worked than the other, this near approach to equality may be in part accounted for from these circumstances. Some other St. John's-day rye, which the author had sown on the 12th July on inferior, more chalky, and less highly manured land, was, on this day, about 16 inches in height, disclosing as yet no ear. The Tyrolese rye, sown on the 19th of September, by the side of two bouts of St. John's rye, was now, on the 17th of April, considerably more forward than the latter: the Russian rye, sown on the same day, was nearly, but not quite, equal to the Tyrolese: the Russian had rather an inferior soil.

On the 7th of May the author exhibited at an agricultural show a sheaf of Cooper's early rye, sown on the 3rd of September, and a sheaf of St. John's-day rye, sown on the 21st of June. They were nearly equal in height, being about 3 feet 6 inches high, the St. John's-day rye having rather the advantage in that respect; but the Cooper's rye was then nearly full grown in height, ready to come into blossom, and the culms apparently would not have been eatable many days longer, while the St. John's-day rye had its ear scarcely developed, and, as its subsequent use showed, was destined nearly to double its then height, and to continue eatable for nearly a month longer. At the time of harvest, Cooper's early rye proved wofully deficient in grain, not yielding more than 10½ bushels per acre, which Mr. Cooper has informed me had also been the case in Essex, so that the seed must be dear this year; but otherwise was a good and even crop. The St. John's-day rye and Russian rye sown on the 3rd September were nearly equal to each other in bulk; their produce in grain has not yet been proved. The common rye was far inferior in bulk of produce to either of the other three sorts, and

this variety ought to be proscribed, and never more cultivated by any good farmer.

Mr. Cooper has informed me that he currently has his early rye in a state sufficiently forward to begin soiling by the middle of April; as it appears, by the foregoing details, mine would have been in April, 1846, if I had possessed a sufficient supply.

It is needless for me to expatiate on the great advantage arising to the farmer in the increase of dung, from having green-meat ready to put before his horses and beasts in the stable and stall from the middle of April to November, and upon the much greater economy of supporting his stock on green-meat than on dry food. And although the St. John's-day rye might be cut as early as that, if sown at Midsummer, having, as we have seen, been 22 inches high on the 17th of April; yet when an additional three weeks or month of growth will double or even treble the bulk on the ground, it appears a waste, and almost a desecration, of the good gifts that are bestowed on us, to cut it in that embryo state. I also think it right to mention, as an advantage incident to the sowing at Midsummer of St. John's-day rye, or any other cereal, for green-meat to be eaten in stable or stall, that I find it an excellent opportunity for sowing with the rye either sainfoin or permanent meadow grasses. During winter the long overhanging blades protect the young grass plants from being drawn out of the ground by the frost, which I have found to be by that operation greatly destructive of autumnal-sown grasses, particularly in calcareous soils, and also in peat, and doubtless it would be so also for clover. The Midsummer season enables the farmer completely to cleanse the soil from all root-weeds, and also to pulverize it well; and there is no season at which either sainfoin or permanent grasses vegetate better, or can be more accurately rolled or sheep-trodden. I do not extend this proposition to rye fed off by sheep, never having sown grasses with any rye destined to be so applied, and being apprehensive that the sheep might tear the young grass-plants out of the ground, more especially as their roots would probably have been loosened by the winter's frost; and it might be necessary to depasture the rye before the grasses would have regained a firm anchorage in the soil.

The facts I have above stated strongly illustrate the expediency of early sowing for the St. John's-day rye. My crop of it sown the 21st of June proved very thick and nearly 7 feet high. My crop sown on the 12th of July was considerably inferior. My crop sown on the 3rd of September barely kept even pace, in bulk, with its Russian neighbour. My crop sown the 19th of September was decidedly inferior to its Tyrolese and Russian neighbours. It is therefore injustice to a plant, which in its proper season and place may be highly useful, to sow it out of

season; the result can only lead to its condemnation, and the cultivator, by this injudicious step, becomes deprived of a valuable auxiliary for fodder and manure, which he might have enjoyed, had he put the seed into the ground in due season.

I would, therefore, strongly recommend to every farmer in the Southern counties who studies the increase of manure, and frugality in his stable and stall expenditure, to sow every year a certain breadth of Cooper's early rye, sufficient to last him from the middle of April to the second week in May, or middle of that month; and a somewhat larger breadth of the St. John's-day rye, to succeed the former, being sufficient to last him to the third or fourth week in June. With the aid of these two he can well keep his stock tied up until the racer vetches, winter barley, common winter vetches, and clovers come in, and place him at his ease, with a latitude of choice of green fodder.

Should the grain of rye be his object, either for sale or for rearing or fattening cattle, the Tyrolese giant rye, the great northern rye, or the Russian broad-leaved rye, or, according to Le Bon Jardinier, le Seigle die Vierlande, are better adapted for that purpose than the common rye, or St. John's-day rye.

If any gentlemen should feel disposed to try any of these varieties of rye, they will naturally inquire where they can procure the seed. The numerous members of the Royal Agricultural Society have the best means of ascertaining the extent of the supply which they can obtain from their own peculiar seedsmen, Messrs. T. Gibbs and Sons, and from the several other eminent seedsmen in London, whose attention has for more than a twelvemonth been called to the subject by the papers which have appeared in the Society's Journal from the pens of Mr. Pusey and others, and the members are also the best judges of the fidelity and accuracy with which those traders respectively respond to the orders they receive. But failing a supply from those quarters, I would refer my readers to Messrs. Vilmorin, St. Andrieux, et Co., 30, Quai de la Megisserie, dit de la Ferraille, Paris, of whose tried correctness, accuracy, and fidelity —of whose extreme courtesy and liberality—of whose varied, extensive, and freely imparted information—of whose numerous, curious, and valuable agricultural experiments, nearly thirty years of almost annual dealings impel me to speak with the utmost confidence and gratitude; and from whom I do not recollect that I have ever failed to obtain whatever quantity of St. John's-day rye I wanted. But should the orders issued to them exceed their supply, I can also state that Messrs. Booth of Hamburgh have occasionally supplied me with the same article, and that the goodness, cleanness, and extensive and curious variety of their seeds, and careful attention to orders, merit very high praise. It

is also more than probable that Messrs. Peter Lawson and Sons, No. 1, George the Fourth's Bridge, Edinburgh, the seedsmen to the Highland Society, may be able to supply the article required. For Cooper's early broad-leaved rye, I recommend an application to Mr. Thos. Cooper, of Ardleigh Wick, near Colchester, he being the only person whom I certainly know capable of supplying that valuable variety, the origin and history whereof I hope that he or some other able agriculturist will communicate to the public.

Should any farmer raise a supply of seed of the St. John's-day rye, for his own use, I strongly advise him to sow a part, but not the whole, so soon after the harvest as he can get it threshed, and to reserve one half of it to be sown in the following summer; for, however fine the season, and however warm and forward his land and situation, he will scarcely get it threshed out till near the end of July, which is a month later than the best season for sowing it, if he would see the plant in perfection. If he will sow the reserved portion at the Midsummer following, and is not thereafter satisfied with his produce, let him then impute to the author that he has been grossly misled.

XXV.—*On the Potato Disease.* By F. J. Graham, B.A., F.L.S.

Prize Essay.

Of the innumerable hostile agents with which the cultivator of the soil has to contend, some he is able to keep in check by the ordinary course of husbandry; others have from time to time engaged the attention of men eminent in various departments of science. Still there is mischief in the field, the origin of which is not yet "dreamt of in our philosophy." Such *was*, perhaps still *is*, the subject of the present Essay—the Potato Disease of 1845, notwithstanding the most minute investigations have been made by some of the ablest Professors both in this and foreign countries in order to ascertain its real character. But probably few subjects of the kind ever presented greater difficulties, its cause being imperceptible, its attack inevitable, its remedy apparently impossible.

The first intimation I received of it was a mere rumour about the 12th of August, 1845; and on the 16th this was confirmed by Dr. Bell Salter in the "Gardener's Chronicle." I had then used my ashleaf kidneys and one bed of Fox's seedlings, without finding any sign of disease; but ten days afterwards, on taking up another bed of Fox's on the south side of a path which divided them, 2 bushels on two rods were more or less affected.

When the first bed was dug the haulm had not faded, but that

of the latter had in the mean time turned yellow, with brown spots on both leaves and stalks, and afterwards died off black. The roots were also decayed. In the garden of a nobleman in Warwickshire I also saw a crop grown within the walls, in which I could not perceive one unsound tuber, while those of a later sort grown in the border outside the walls were badly diseased.

On the 20th of August I had several roots of Shaw's taken up, which I found affected. The leaves were yellow, and the brown spots upon them spread rapidly, running down the petioles and forming circular blotches on the stalks, both above and below the point where the petiole was inserted, passing through the inner coats of the bark and the woody portion into the medulla, the structure of which was prematurely broken up at the lower extremity and stained of a dark colour, but remained for the most part healthy and entire towards the tops; blotches appeared also at the base, and on other parts of the stalks, and wherever these appeared the bark easily peeled off; and there were generally two or three distinct blotches on a stalk, with healthy-looking bark intervening, sometimes all these united. This crop was taken up on the 29th and 30th of August, at which time I found the tubers worse than when I tried them the week before; some of the roots were entirely diseased, others withered and dry, a few apparently sound. Many of the potatoes were marked with the too well known brown blotches; some in narrow uneven bands, separated by a small portion of sound substance; others were brown all over. The greater number were affected at that point where they were attached to the stalks or cords; these cords were nearly all diseased, yet a great many of the potatoes attached to them were quite sound. I also observed in some few cases that diseased potatoes were hanging to cords free from any trace of disease. Very frequently the cords broke off about three inches from the potatoes, where the disease had been most intense, and remained hanging to them.

The only way in which I can account for the entire crop not being destroyed is, that at the point of connection of the potato with the stalks or cords there is a sort of hylum as between the stalk of an apple and the spur on which it grows; and if the potato remains until ripe it separates spontaneously at this point, in the same manner as fruit. When, however, a fruit-tree is much checked in its growth by unusual drought, it is not uncommon for the footstalks to shrivel up, and for the fruit to remain hanging in its half-grown state to the spur. I believe the potato received just such a check during the hot weather of last autumn, and the cords shrivelled up in consequence, and became incapable of transmitting the mortiferous fluid to the tubers themselves: thus they escaped; and at the time of digging, as before observed, a very

great number of these shrivelled cords still adhered to the potatoes.

The discoloration had not descended more than 1-8th of an inch under the cuticle, but a much greater quantity of the large potatoes was affected than of the small ones.

Two pieces of Jersey blue at this time, September 3, began to assume the same morbid appearance as the others; the tops, it is true, were green, but it was not of a healthy hue, and on a close inspection the awful spot was perceptible both on the leaves and stalks: most of the lower leaves and petioles were diseased; many had even fallen from their axils. I marked several plants, and picked off every spotted leaf, but in two days there were as many more, although the tops still continued of a sickly green colour, even after the blotches had encircled the stems.

The weather about this time was very hot and dry. These potatoes were taken up on the 22nd of September, nearly a month sooner than usual, and of these also the large ones were much more diseased than the small ones. A neighbour also, whom I supplied with sets of this variety, lost all except some of the small ones. The potatoes, however, did not generally grow so large last year as in ordinary seasons. I also observed at the time of taking up that a great number of the more slender plants which were quite dead, and appeared therefore to have yielded to the first attack (as the tubers all parted from the roots), had not a single unsound potato under them, while the strongest plants, of which the haulm at top continued green to the last, had in many cases not a sound one attached to them. My loss was heaviest on the blue, and, including those picked out since they were taken up, amounted to one-sixth of the crop.

The above is a brief description of the appearance both of early and late sorts; the former being constitutionally the most tender, the latter the most robust.

I have examined many other crops in several counties of England, but found them differ only in degree: of some upwards of 9-10ths being destroyed, of others scarcely any.

It has been generally considered that the disease was quite new to this country. I am, however, inclined to think otherwise, if only from the following circumstances which have come under my own observation:—

In 1841 I purchased one ton of York red potatoes in London, for planting, and while they were being cut I noticed exactly the same kind of blotches upon them running about ¼ of an inch under the skin, and containing the same dark shiny kind of fluid; and although these parts were cut out, more than half of the sets never came up, and the shoots of those that did were not thicker than straws, and many of these rotted off in blotches afterwards. (Just

the same result has taken place this year with *some* diseased sets which I planted for trial, although *some others* produced tolerable plants.) In the autumn of the same year, while taking up some Shaws, I also had several bushels discoloured in a similar manner to those of last year; some partially, others all over. It did not, however, occur to me to examine the haulm at that time; but I have referred to the persons who took up the crop, and find they also remember the circumstances above related. I have also been informed that this disease has been known for some years on the warp lands in Yorkshire in cold wet seasons. It has also been stated in the "Gardener's Chronicle" to have been prevalent in a part of Ireland for the last three or four years, and in one place in the Isle of Thanet in 1844; and I have little doubt, from the tons of diseased potatoes which I have seen thrown away by one grower in such seasons, that it has often visited us before; but never having been so universal, nor the press so available to make known the disasters to which the agriculturist is liable, it has passed among other injuries which, from their frequency, he is accustomed to slight.

It has also been supposed that certain sorts were less obnoxious to the disease than others, especially those recently raised from seed, from a notion that the old sorts were superannuated, for which there is not the least foundation; for very few really old sorts are retained in general cultivation, having been superseded by the Jersey Blue, Prince Regent's, and many other comparatively recent sorts, which were as much affected as any of the older kinds in some places, if less so in others. And as to last year's seedlings, I can state, from my own experience of a few I grew, that *they* were equally affected.

The only sorts which escaped entirely if allowed to ripen were the ashleaf kidney and early frame, where planted forward. And by a letter received from the Rev. J. Robertson, Secretary to an Agricultural Society at Bridgtown, Nova Scotia, whose duty it was to lay the returns of that province before the House of Assembly, I learn that the only sort which escaped there was a *very early* kind called "blue noses," and this was not touched, while of their later kinds 7-8ths were destroyed. I have no means of satisfying myself as to the collective loss in this country, but probably it would amount to about one-half of the crop. These were, however, by no means wasted; some having been converted into starch, which unless proper apparatus was employed was a troublesome process, and the drying difficult. I did not obtain more than 8 lbs. of fine starch to the bushel, as there was some waste, and the potatoes could not be grated entirely by hand. But the greater part were given to cattle, which throve very well upon them if boiled, or even given raw in moderation.

As regards the weather of the year 1845, this had been very favourable for planting and hoeing, and the appearance of the growing crops was for the most part as promising as could be wished up to the beginning of July, when they were rather at a stand for want of some showers, the weather having been very dry and hot, with only one or two slight exceptions, for six weeks, the thermometer ranging in fact, according to the registry kept at the Horticultural Society's Garden, from 1½° to 4½° *above the average* for the last *nineteen* years; in short, it was beautiful hay-making weather. It then suddenly changed to the most extraordinary contrast that ever I witnessed even in this fickle climate; the atmosphere being for upwards of three weeks one continued gloom, the sun being scarcely ever visible during that time, with a succession of the most chilling rains and some frost; and for six following weeks the thermometer ranged but from 1½° to 7° *below the average* for the last nineteen years. Still the crops, upon a *general view*, did not look worse than they usually do after being beaten about by heavy rains; that is to say, they had a soddened appearance. That they had become debilitated I cannot entertain a doubt. but they exhibited at that time no other signs of it than that. But again the weather became suddenly dry and hot, and continued so up to the latter part of September, at which time the light lands were as dry as dust as deep as the plough had penetrated. I of course only speak of those places which I visited; but I may perhaps be allowed to state, upon the authority of the gentleman before mentioned, who is also the occupier of one or two farms, that a similar extreme variation of the weather occurred in Nova Scotia, namely, "very *unusual cold rains, suddenly succeeded by* 90° *of heat.*" It also appears from accounts from France, Belgium, and other countries visited by the disease, that their season was very similar. M. J. Decaisne, in his excellent "History of the Potato Disease," p. 75, says, "The *unusual heat* at the beginning of July was suddenly succeeded by a long continuation of *extraordinarily cold, humid,* and *cloudy weather.*" Various other causes have been assigned for the disease; the Rev. M. J. Berkeley, in an elaborate memoir illustrated by several varieties of parasitic fungi, attributed it to the insidious attack of a species of botrytis, which, singularly enough, had never been observed before, and was named in consequence by Mlle. Libert* (who is said to have first discovered it) "devastatrix," by M. Montagne "infestans," and by M. Desmazières, "fallax." When it was first noticed, it was said to thrive only on the living leaves of the potato, sparing even the stalks; it has, however, been admitted since, that it attacks the stalks and

* The Rev. M. J. Berkeley.

potatoes also; but in order to produce the disease of last season, as justly observed by M. Decaisne, it *must have* attacked *every plant*, which it certainly did not; for I most carefully examined the leaves and stalks of several crops last year at several intervals, with an excellent glass, without meeting it, except upon one occasion. We are also informed that the most skilful observers* on the Continent had examined whole fields without perceiving the least trace of this fungus; and M. Desmazières states that he had not been able to perceive more than five or six "boutons" of botrytis on many hundreds of infected potatoes. I have also examined a large quantity continually, and have very rarely met with any mildew at all resembling it, although other kinds were common. I cannot help thinking, therefore, from the recent discovery of this minute parasite, that its peculiar habits have been laid down with too much precipitation, sufficient time not having elapsed to afford proper opportunities of ascertaining whether it really was so much more dainty than others of the same family or not. I have met with certain cases which lead me to think it is not so. In March last I procured several diseased plants from a market-gardener, and, having placed one of the old sets on the border of a late vinery, in a few days a tuft of mildew appeared on it, the plants of which closely resembled a drawing of the botrytis infestans made from a leaf kindly sent me by Mr. Berkeley himself. The set was then in a moist state of decay. I also found a similar fungus on the 11th of April on some shoots pulled off diseased potatoes, and sent me from Sydenham, which had been lying on the same border ever since the 10th of February, being of course quite dead and brown. But what is still more remarkable, I found on the 11th of April a mildew in similar tufts, spreading over the mould in a flower-pot in which I had planted a diseased potato for the sake of experiment, and by sprinkling a little more moist earth over it I kept it still increasing for upwards of five weeks, although numbers of minute insects of the genus called Podura fed upon it as it became older, and quite consumed it. Many of these plants, as viewed under an ordinary microscope, could not be distinguished from those on the potato-leaf; but Mr. Berkeley, to whom I sent a portion of the mould, found two distinct species upon it, but did not consider *either* to be the true botrytis infestans; and I have since been able to satisfy myself that one of the species is not identical with that; and from Mr. Berkeley's high character, little doubt can be entertained as to the other. It may, however, be observed, that a wide difference exists in the several specimens of botrytis infestans with which Mr. Berkeley's memoir is illus-

* MM. Decaisne, Leveillé, Thuret, &c.

trated. But whether or not these plants, or any others which I have found and drawn, are the true botrytis infestans (figs. 1, 2, 4, 5, A; and fig. 4, B), it is clear they must be very nearly allied,

A.

1.

On dead shoots from diseased potatoes from Sydenham. April 11, 1846. Plants pellucid, tufts white.

2.

On rotten moist stalks, from market garden. April 17. April 7, tuft white.

3.

On Mr. B.'s leaf, April 16, the large plant floating over the edge of the leaf, when cut, pellucid; large clusters opaque if not in a good light; tuft greyish.

4.

On mould in flower-pot, in which diseased potato was planted; brilliant pellucid; tufts steely white, some creamy afterwards. April 11.

5

On potato-leaf damped and placed over mildew, on flower-pot. April 11.

Drawn April 20.

a, b, c, d, e, f, sporidia which have discharged their contents on these plants.

Botrytis infestans.

as well in their habits as in general characters; for, having plucked a small leaf from one of my potatoes, and placed the under-side of it upon the mould in the flower-pot, in doing which the leaf, being damped, licked up a little fine earth from the surface, in eleven days I found the same species growing on the decaying leaf as drawn in fig. 5, A. It will be perceived that the plants thus obtained approach still nearer* in appearance to those on Mr. Berkeley's leaf than those do which were found on the bare mould, although they sprang from the spores of the latter. I also scraped a small portion of the under-side of a living potato-leaf, and stuck a little of the *mould* upon the spot, and in a few days that part of the leaf was covered with plants of the same species, but smaller than either those on the mould or those on the decaying leaf. The *fungus*, however, *did not spread beyond the spot* that *I had abraded*. Two things are proved by these experiments; namely, that plants of fungi, so closely resembling the

* Professor Henslow thinks it not improbable that uredo becomes puccinia; and I am quite certain these plants grew much larger and became more branched on moist decaying matter than on the living leaf.

botrytis infestans as not to be distinguished from it by the highest power of an *ordinary* microscope (I mean that called Dr. Hooker's), will grow on very opposite substances, and *that they grow larger on decaying matter* than on the living plant, on which they did not extend beyond the injured part of the leaf.

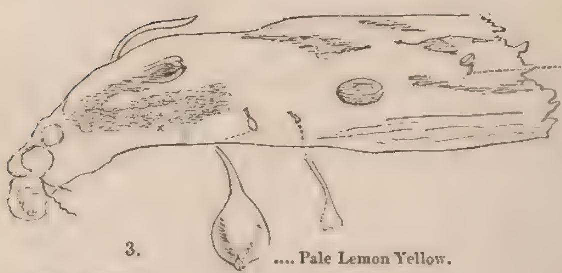
B.

1.

On dead potato stalk, smoky-yellow and black.—J. C., Feb. 1846.

2.

Smoky-yellow and black.



3.

× Black bristles.—J. C.

4.

From blotch on shoot from diseased potato. April 3, 1846.
All these plants on 1-7th of an inch by 1-16th of an inch.
Botrytis infestans?

From these circumstances, and from the fact that I have never yet seen the mildew on a healthy leaf, I cannot entertain the

opinion that the botrytis took the initiative part in the late calamity. Indeed, I repeatedly rubbed leaves covered with it on the underside of my potato-leaves without producing any effect whatever; and I cannot but think that, if the leaves and stalks of the potato had undergone half as close an examination as to the state of their health at the commencement of the late attack, as they have subsequently for the discovery of mucedinous filaments, we should long since have arrived at a more satisfactory conclusion; whereas, little more than ordinary notice was taken of the *health* of the plants, while the mildew was magnified by a power equal to 780 diameters.* I have observed between twenty and thirty other kinds of fungi on the dead stalks of last year, as well as on diseased potatoes—of some of which I give figures, as they are very curious, and some of them I believe new; and I think the finding of them in such a situation confirms the general opinion that the proper food of fungi is, in almost all cases, matter at least in an incipient state of decay. I scattered the spores of many of these amongst the leaves of my plants also without injury to them. One of these, however (fig. 5, c), I found at the bases of many stalks at the time of taking up my crops last year; and since, upon upwards of two hundred stalks picked up indiscriminately, both inside and out; but, as it fructified freely during the winter, both in my greenhouse and out of doors, I look upon it merely as an attendant upon decay, not the cause of it.

Another opinion existed, that the disease was caused by insects: and, if the swarms of green flies which I found during my examinations of the haulm last year, on the underside of the leaves, had been generally observed, I should not have been surprised if such an opinion had been even more popular than the preceding. But the presence of this species has never, as I believe, been publicly noticed in this country, although, in America, in 1838, another species was observed by Dr. Harris,† in great numbers, on the potato-haulm and other herbaceous plants; and he thinks they contributed as much as the dry weather to diminish the crop by puncturing the upper parts with their *beaks,* drawing out the sap and poisoning the parts—for *these* shortly after *withered,* turned *black,* and in a few days dried up, or curled and remained stunted. The Doctor's odd description of their singular habit of "dodging round" to the other side of the leaf to elude being taken, in addition to a general resemblance, left no doubt on my mind of their being pretty closely allied to those which I found; but the Doctor describes his species as Phytocoris lineolaris. I did not perceive that those I found did any harm. I how-

* The Rev. Mr. Berkeley's memoir.
† "Treatise on Insects," 1841.

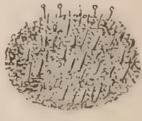
C.

1.
On decayed spot on vine leaf, April 20, pellucid stems, pale brown heads.

2.
On potato leaf, trial plant in pit, April 19, leaf decayed.
Monilia racemosa ?

3.
On Dahlia shoot, rotted off May 4.

4.
On diseased leaf of tare, stems pellucid, sporidia yellowish, April 11, 1846.
Botrytis Viciæ.



5.
On potato stalk, when taken up in October, like a grain of gunpowder; in groups, fructified, March 19, sporidia pellucid, bristles black, on *every* stalk where disease appeared.
Sphæria.

6.
On dead potato stalks in the winter. Like charred fibre on a pellucid thread—sporidia pellucid.
(*a*) Pellucid.
(*b*) Egg-like shell (sporidium) enclosing black fibres as above.
Physarum carboniferum.

7.
On dead stalks of potato in winter. Upper part snow white; lower, dirty yellow.

Peziza.

8.
On dead stalk in winter. An olive velvety mass, from a purplish stain at first; lower part black; upper, black and gold—very curious.

Helmisporium.

ever sent some of them to an eminent authority, well known to readers of the Royal Agricultural Society's Journal by his valuable papers; and his reply was, that he did not think them accessory to the disease. It is named by him Eupterix Solani, as it does not agree exactly with any named specimens with which he was acquainted. This far-famed disease, therefore, brings out a new insect as well as a new fungus.

I did not find the common Aphis upon the plants out of doors, but it attacked them seriously this year in pits, and injured both the upper and under surfaces of the leaves considerably. I also observed a small black fly, a species of Molobrus,* which bred amongst some old potato-stalks in my vinery, puncturing the

* M. fucatus, figured in the 'Gardener's Chronicle,' November 22, 1845.

leaves on or near the veins, the marks of which might sometimes be traced a day or two afterwards; but I am not aware of any extension of the injury.

By some persons, I believe, it has been considered that a peculiar state of the atmosphere, as regards electricity, had considerable influence in producing the late disease; and, notwithstanding conflicting results have been published, both recently and fifty years ago, of experiments as to its effect on the growth of plants, I cannot come to the conclusion that it is an unimportant agent; for, in the application of so subtle a power, circumstances, with which in the present state of our knowledge we are unacquainted, might negative the effect of it in one place and not exist at all in another. I am of opinion, however, that, in the case before us, electrical influence was not very considerable.

I do not consider it necessary to refer to any other causes to which this disease has been wrongly attributed; at any rate not in this place; and I will therefore at once proceed to state my own views of the true cause of the late calamity.

This I believe to have been no other than *Gangræna vegetabilis*, or, as it is commonly called, *canker*, a disease to which I have paid some attention for many years past. I may add, that my opinion does not at all depend upon the discovery of this disease in the potatoes at Bicton* this year, but arose from a close examination of my own last autumn, at which time Dr. Lindley also, more than once, pointed out the resemblance of the blotches to those of canker,† in the 'Gardener's Chronicle.' It is sufficiently known to most persons by its attacks upon fruit-trees; some of our most valuable sorts, as the Golden Pippin and Rennet and Ribston Pippin, being frequently destroyed by it—I believe, from a peculiar delicacy of constitution, which will not endure cold and wet situations, but will be perfectly free from it in warmer and drier localities: at least, I have found such to be the case with a Golden Pippin tree, which while in an unfavourable position was literally eaten up with canker, but, having headed it down to the stem and removed it to a light dry soil, and a situation much warmer than its former one,‡ it has stood six years without a single blotch of canker upon it, and last year produced a fine crop. On the other hand, I have had some sorts, such as the Quarendon, planted in the former situation, close to the above, without being in the least affected in twenty years, it being more hardy. Neither have I ever met with canker in the wild crab, or, to the best of my knowledge, in any indigenous plant—if even *that* be

* Feb. 21. † Aug. 23, 30.

‡ The leaves and shoots of those vines which ran out into the open border were much blotched this year and last, but others growing inside were perfectly clear and healthy.

so; for apples are said to be natives of Syria, and are alluded to in Scripture; although many of our oldest sorts bear French names, and no doubt were brought to us from Normandy. Apricots, and many other trees from warmer climates, are very liable to its attack, some varieties more so than others; thus, last spring, I had one or two branches of Moor-park apricot, which I had budded three years before on the common sort, destroyed, while the parent plant was uninjured, being, doubtless, more hardy. If a blotch of canker on a fruit-tree is examined soon after its appearance (which is often very sudden when hot days in spring are immediately succeeded by sharp frosts or cutting easterly winds), it will be found that the brown or ferruginous fluid corrodes the inner coats of the bark in an uneven manner, just as it does on the potato—usually forming a band or ring round the shoot. This, however, frequently throws out granulous matter, as an effort to counteract its progress, which is sometimes successful for a season; at other times, and much oftener, the canker is victorious, following the course of the medullary rays into the pith; the contest is then at an end, and the upper part of the shoot dies. It often happens also that two or three isolated blotches arise on the same shoot; hundreds of instances of which I met with on the stalks, as well as on the potatoes themselves, last year: in fact, it is characteristic of the disease to appear in that form. The potato-stalks, however, being more herbaceous, and constructed to endure only for a single season, become a quicker and more easy prey to its mortiferous foe. The same effects are likewise frequently produced on the leaves and stalks of many other tender and half-hardy plants when exposed to sudden and violent changes of temperature. Cauliflowers, if badly wintered, and cucumbers* and melon-plants, are more or less subject to this disease, and are soon utterly destroyed by it. Gardeners usually term it "damping," or "shanking off." Immense quantities of cucumber-plants were destroyed last season as stated in the 'Gardener's Chronicle'—some I witnessed myself; and if in circumstances favourable to its development, mildew, in one or other of its varied forms, succeeds. Several other plants† were affected in a similar manner; and the same disease has this year caused sad havoc amongst tulips, which looked very healthy during the early part of the year, but were struck by the cold and wet weather which ensued afterwards; many of the blotches on the leaves being also covered with mildew, as in fig. 1, D.

* The following answer was given, May 23, to a person who complained of his cucumbers being diseased, by the editor of the 'Gardener's Chronicle:'—"It is impossible to say what these cucumbers ail. They are cankered: one would have thought that they were overwatered in too low a temperature," &c.

† Carrots, onions, tomatoes, mangold wurzel, &c., of my own growth.

D.

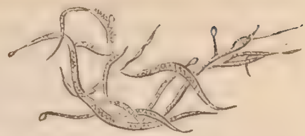
1.

Pellucid stems, pale green, heads with globose sporidia.

Aspergillus glaucus.

2.

All pale brown, heads like brooms.



3.

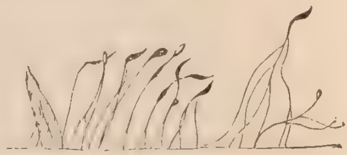
Transparent, except the netted parts.

1, 2, 3, on starch bread (April 14, 1846) from potatoes.
No. 1, on decayed tulip leaf, May 11.

4.

Grey; stems pellucid; on potato, dark inside when cut, afterwards became as *hard as stone.* v. specimens.

Aspergillus penicillatus.



5.

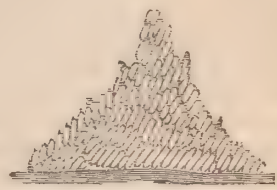
Black, on putrid potato.

Pachnocybe subulata.

6.

Stems pellucid, sporidia whity-brown, on diseased potato leaf in pit; also on pith of dead geranium.

Monilia racemosa.



7.

In the middle of diseased potato, dirty yellow, shiny.

The potatoes at Bicton (Devon), under a melon-frame, were also described by Mr. Barnes, the gardener, as looking *quite healthy;* and others also, planted in borders in the open ground, looking very flourishing during January last, but, on the 9th, 10th, and 11th of February, sharp frosts occurred, and the mean temperature of the week was 1½° *below* the average for the last twenty years: and what was the temperature of the week previous to this?—why 7° *above* the average for the same time. And what was the consequence? It is thus described on the 21st of February:—"Another sample from tubers, *supposed to have been sound,* also manifested the symptoms in *putrifying blotches on the leaves,* accompanied by the *underground grangrene.*" *

* Gard. Chron., Feb. 21.

On examining some sickly-looking plants of tares lately, which I found here and there amongst a very fine healthy crop, I was also rather surprised to find that this diseased appearance, instead of being produced by Botrytis viciæ (as it *has* been supposed to be), was, in *every instance,* owing to *blotches of canker, some* on the *stalks,* others *underground;* the greater number of diseased plants having no mildew at all on them; others, however, producing fine crops of Botrytis viciæ on the leaves, and Monilia racemosa, or an allied species, on the ulcerous spots on the stalks (fig. F). But I cannot perhaps name any plant by which the

F.

× Gangrenous blotches on tare plant. May, 1846.
1. Botrytis Viciæ on these leaves.
2. Monilia racemosa on stem (none on lower blotch).

real cause and nature of this disease may be so easily and clearly demonstrated as the common scarlet geranium, which, although considerably more robust than the potato, is, if ill treated, very liable to canker. Often have I seen this favourite plant, after enlivening our flower-beds during the summer, taken up in the autumn (usually after being a little nipped) and thrust into a dark shed, for want of better accommodation, and watched the "rise and progress" of the blotches on the stalks and leaves until the

withering circle was completed round the stem. Sometimes *even then* it will not give in; the upper leaves will still retain their verdure in spite of it, while a particle of vital wood remains. (The Jersey Blue potato will, in good land, also stand out as stubbornly.)

On the other hand, I have seen, not only in former years but in the present one, geraniums which had been carefully nursed during the winter, destroyed in a few days by the same disease, caused by too sudden exposure to the variable weather of spring; sometimes without, but more frequently with, a copious supply of pump-water.

Analogous cases are mentioned by the celebrated Dr. Darwin, in 'Phytologia,' which I hope I may be allowed to introduce here, as they appear to accord so nearly with the phenomena of last season. He says,—"In the hot days of June, 1798, I twice observed several rows of garden-beans become quite sickly, and many of them to die, from being flooded for an hour or two with water from a canal in the neighbourhood; which I ascribed more to the sudden application of too great cold, after being much enfeebled or rendered inirritable by the excessive heat of the season, than to the too copious supply of water. On the contrary, when plants have been too long exposed to a *less stimulus of heat than natural or usual,* the spirit of vegetation becomes accumulated; and if they are suddenly subjected to much greater heat, their too great increase of action induces *inflammation,* and consequent *mortification* and *death*—as occurs to those people who have had too much warmth applied to their frozen limbs. Experiments of this kind were instituted by Van Uslar. He increased the irritability of *Euphorbia* peplus* and *esula* by secluding light and heat from them, and when he exposed them to a meridian sun they became *gangrenous,* and died in a short time."

In order, however, to bring the case quite home, I made this last experiment upon the potato-plant itself, in the following manner:—

On the 27th of December, 1845, I had planted 14 sound potatoes, and four in various stages of disease, in pots, and placed them in a small vinery, slightly heated by tan. Every one grew, but the sound ones the most vigorously; as may be seen by the accompanying specimens of their leaves. I never saw plants with more healthy foliage; for the season was unusually mild, not a single frost, I believe, having occurred during January, and I had not stinted them of water. On the 21st of March I selected the most flourishing plant from amongst them, and, having watered it thoroughly, set it at once in rather a dark corner of a dairy with a glazed window, which was closed at night and open by day—

* Succulent plants.

the temperature was then 40°, it being usually 44° while the plant was there. On the 2nd of April I brought it up, when the only apparent difference in it was, that it was not of so dark green a colour as when I placed it there. Still it was by no means etiolated. I at once set it in the sun, which was then bright, and at five o'clock P.M. *brown spots* appeared on three of the leaves.* I continued to set it out by day, although the weather became dull, and protected it in a cool pit at night. On the 6th of April nearly all the *leaves* were *blotched*, more or less; but, although I examined every one separately with a Stanhope lens, *I found no mildew on any one.* On the 20th of April several petioles *doubled down*† at the places where blotches had formed, and the upper parts SWUNG BACKWARDS and FORWARDS in the air, as I remember to have seen them *last year;* and on one withered spot there was a species of mildew (fig. 6. D.). On the 30th of April only two leaves at the top were free from blotches, and SEVERAL OF THESE HAD FORMED ON THE STALKS. I subjected another plant to similar treatment a short time afterwards, and THE RESULT WAS THE SAME; the figure (E) being composed of stalks and foliage from both plants, as seen May 16th. I afterwards took another victim, which is now (May 23rd) in a progressive state of decline. The two former plants were turned out of the pots on the 29th of May, in the presence of a gentleman to whom I have before referred, but none of the potatoes were diseased, although the roots of one plant were quite withered. The other had not become diseased down to the roots. My own opinion, however, remains the same. One of the most eminent botanists in the kingdom, to whom I communicated my experiments, also concurred in my views as to the nature of the disease; and assured me that he did not consider that this at all invalidated them—as, however near I might come, it was almost impossible, in such an experiment, so to control the elements as to render circumstances exactly alike, and that the blotches on the haulm alone proved the identity of the disease. Being in a pot might make some difference. Many plants last year had no diseased tubers, although badly diseased in the haulm. Every other plant in my vinery continued in perfect health, except two, which I shall mention presently. On the 20th of April a sharp frost cut the forward potatoes out of doors, and, *early* in the morning of the 21st, drops of brown fluid were resting on the leaves, very similar to that seen in diseased potatoes. I plucked some of these leaves, and inserted part of one of them under the bark of a potato-stalk in my vinery. THIS has produced a LARGE BLOTCH quite round the stalk, and SPOTS ON THE LEAVES ALSO, which will in a few days *destroy the*

* *Vide* specimens. † *Vide* fig. E.

E.

Ash-leaf potato (trial plant), drawn May 14, 1846. × Monilia racemosa.

*plant.** I have since tried it on another, and this is also working in the same manner. This experiment I consider most important, for it not only shows that *cold* suddenly succeeded by *bright sun* (as it was between six and seven o'clock on the morning of the 21st of April) will convert the sap from its natural colour to brown, but, from its having acquired thereby a *phagedenic property*, it also points to the same causes as the origin of canker, and thus confirms the view which I have taken of it in a former part of this essay.

It also proves the correctness of its analogy with the effect on frozen limbs as mentioned by Darwin. And does it not also show that canker is neither more nor less than the *mortiferous principle* of the *vegetable system,* as the true gangrene is of the animal? For, if either is arrested before it has entered into the general circulation, both animal and plant may be saved, but, if allowed to extend into the more vital parts of either,† death is

* This plant was sent to the R. A. Society's Rooms, where it died in a few days.

† I saved several bunches of grapes last year by cutting out the blotches on the stalks as soon as they appeared.

inevitable. By what means then, it may be said, are plants saved from total destruction after being nipped by frosts? I answer, they frequently *are* entirely killed, but if bright sunshine ensues, as in the case I have cited, the tissue of the frozen part is ruptured, and the sap *escapes* as I saw it; continuation of sunshine dries up the frozen parts, and the margin of the injured spot is healed by matter thrown out by the vital energy of the plant. If, however, a plant only slightly affected by frost is watered all over before the sun shines on it, and shaded for some time afterwards, it will recover entirely, as I have frequently experienced, if it be in good health at the time; but if it had been previously exposed to unfavourable conditions, by which its health had been, as it were, secretly undermined, I would not answer for its not becoming diseased or gangrenous in consequence: the vital energy of a plant depending upon certain conditions adapted to its own peculiar nature, and its diseases or premature death upon the partial or total deprivation of them.

Slips * of diseased potato it is well known will produce disease, if inserted into others; but simply bruising a sound potato will produce no such effect. In order to ascertain the nature of canker still further, I inserted slips of apple-tree canker into some potatoes as well as into their stalks; I also made a *decoction* of slips of cankered wood in a dormant state, and introduced it into the living stalks by puncturing them with the point of a knife; I also inserted slips of diseased potato under the bark of apple and pear-trees, but by no one of these experiments did I succeed in transferring the disease, but a very little of the *decoction* soon produced a blotch on the shoot of the vine (fig. 1, c). It appears, therefore, that the *mortiferous principle* of plants requires some affinity in the plant with which it is brought into contact, otherwise it will not assimilate its juices to its own condition, although not so close an affinity is required as for grafting or budding, as the canker of the apple-tree produced gangrene on the vine, with which a graft would certainly not unite.

Amongst other eminent authorities, the opinion of Dr. Lindley has been throughout that the disease was produced by atmospheric causes. Lately, however, he has entertained a doubt whether Count Gasparin had not good reason for attributing it to some unaccountable miasma, such as causes cholera and other epidemics, on account of the disease having appeared under circumstances in which atmospheric changes such as I have before described did not occur. To this I can only say that Count Gasparin's tables of the weather may be accurate, but I cannot

* They also destroyed carrots and onions, but did not injure cabbage-plants.

help again referring to the testimony of M. Decaisne and other authorities on the Continent, that the weather was as I have before stated, wherever the disease was observed by *them*. And as to its occurring under glass, I will mention one case which I witnessed, in which, under a mistaken notion, a sudden change was admitted to a range of pits planted with potatoes, which were nearly destroyed in consequence. The proprietor informed me himself that these potatoes had only had water twice since they were planted (I believe he added in November, and I saw them in March, when they had potatoes as large as eggs upon them), and upon those occasions the lights were removed to admit showers of rain. To this, therefore, I attribute his loss, as well as to the fact that a great many squares of glass were broken. They had, in fact, received too sudden and copious a supply of air and water after having been for three months stinted of both: and this is not a solitary instance. *Some grown close* to these were *perfectly healthy*.

To my mind, therefore, the sudden and extreme alternations of the weather last season, by imitating which as closely as circumstances beyond my control would permit, I have artificially produced the same disease upon the potato this year, were of themselves quite sufficient to produce the late almost universal calamity; for it has been shown that these causes prevailed generally, not only in Europe, but in America also, on which continent Mr. Robertson informs me that it is a well-known fact that the potato cannot be grown south of Washington, owing to the constant occurrence of such weather, and he further adds, "Should we happen to be visited with the kind of climate that prevails south of that city, we must expect to experience the same results." And I entirely adopt these words in reference to our own country, and only beg leave to add to them, "*and not otherwise*."

I should be sorry to say, however, that the disease could not be produced in any situation by other means than those which I have shown will induce it; for, from my recent experiments, I am quite satisfied (and I know I do not stand alone) that it is not near so difficult a task to render a plant diseased as some persons may imagine, but there are plenty of cases in which the finest theories carried out by first-rate practice fail to produce a healthy condition. But no case has hitherto come to my knowledge for which I do not consider the causes I have assigned to have been amply sufficient. The plant having been rendered partially inert by the repellent action of cold, wet, and gloomy weather, uncongenial to its nature as an exotic from a warm climate, at that critical period of its growth when in the course of ordinary seasons it would have been about to acquire strength and hardness, but

during which time it was incapable of perfectly evaporating its redundant juices for want of sunshine; they accumulated in consequence, and became vitiated by stagnation in that crude state; and when fine hot weather ensued afterwards, the sudden rush of sap was too great for its debilitated tissues, and the diseased fluid showed itself at the surface in various places, on the leaves and stalks, sometimes in spots not larger than a pin's head, at others in blotches, which rapidly increased if the stimulus of heat was kept up.

The virus of these spots, being of a phagedenic or ulcerous nature, eventually descended into the potatoes.

The effect upon these has been already described at the commencement of this essay, and has been also so well shown by Dr. Lyon Playfair in his comprehensive lectures, that it must be quite unnecessary to repeat it, particularly as he has illustrated the subject by such accurate diagrams.

As to the chemical action of the disease I am not competent to give an opinion. Dr. L. Playfair has stated that he considers it to be owing to oxidation of the debilitated tissues. But Mr. E. Solly attributes it to putrefaction of azotized matter in the stems, but also implies that it might arise from oxidation, if the tissues *were* debilitated, which he, however, doubts. But for my own part, I cannot conceive it possible for plants to be rendered incapable, during a long period of the growing season, of performing their most important functions *without their being enfeebled*, and thus, if this point were conceded, as I believe it generally is, very little difference would exist on this head between two of the most eminent agricultural chemists in this country.

Much has been said about the disease being contagious. Strictly speaking, it is not so, for I had three roots of Shaws taken up on the 29th of August, containing twelve sound and nine unsound tubers, which I placed on the bare ground, taking care to make the diseased parts touch the sound ones. I then covered them over with their own haulm and an old mat. I examined them frequently, and lastly, on the 21st of March, when the twelve sound ones were still without blemish, eight of the others were diseased all over, and one had only the upper eyes sound. In February last I also had twenty bushels of perfectly sound potatoes, picked out of a heap of bad ones with which they had been thrown when they were dug up. I have since had these cut, and, finding them perfectly sound, used them for sets.

It was supposed, from an experiment made by Mr. W. Crum of Glasgow, that *all* potatoes last year contained the principles of disease, in consequence of the pulp when grated turning first ferruginous and afterwards black. But I have found that, if the potato is scraped with an ivory knife instead of an iron grater,

the colour does not become darker than usual, but remains of a darkish fawn. Of course a white potato should be used, not a purple one. I cut one in halves, scraping one half and grating the other, and there was considerable difference in the colour of them, much of the black tint being no doubt owing to the action of the acid of the potato on the iron of the grater. I am still of opinion, therefore, that, as so many potatoes have kept perfectly sound up to the present time, these had in no way imbibed the principles of disease.

If I have been right in attributing the late disease to atmospheric causes, it must follow, *strictly speaking*, that there can be no remedy for it in the power of man capable of general application. *That* must be left to One who has given its peculiar seasons to every land and its unalterable laws to the humblest herb. Still it is our duty to try every means. Lime and sulphur may in some cases under glass be of service in destroying mildew, but I have seen them tried without the least advantage as to curing the disease. The only effectual remedy, if it may be so called, is to pull up the haulm entirely as soon as the disease has seized the stalks; a great many potatoes were saved by those who adopted this method, although they will not be quite so good as if they were left to ripen on the haulm. Cutting off the haulm will not be so efficient in many instances, as the lower parts of the stalks are often as bad as the upper parts. Those who cut the haulm off *before* the spots appeared upon it, however, state that it was equally effectual. The above will, I believe, be the only means of mitigating the effects of the disease, if it should appear again, which I do not however in the least anticipate,* unless an equally ungenial season should occur, in which case it would probably be more severe; and where persons have not been particular in planting sound sets, if on wet cold land, I have no doubt they will have a weak and gappy crop; for, although I have raised healthy potatoes from diseased sets myself, and have seen the same produced by others, yet they are not to be relied on out of doors, as I have before experienced.

Preventive measures are perhaps more in our power than remedial, namely, to plant only sound sets in light open well-drained and well-prepared soil, with less manure than usual—for, as Miller truly observes, the wall-flowers which grow on old walls seldom rise so high, and have tougher roots, and firmer stalks, and smaller leaves than those which are planted in gardens; but in severe winters, when these are frequently killed, those upon walls will receive no injury. And there can be no reason why potatoes grown on a poor light soil should not also become more

* At present they look beautiful everywhere.

hardy. Certainly, those I grew last year on poor light land did not suffer so much as those on stronger soil; and although there may be some exceptions, I believe this to have been generally the case.

I consider on light land well prepared, dibbling holes* for the sets between every other furrow is as good as any other plan; for when the sets are placed in drill-furrows, if heavy rains ensue, the drill forms a trough for the water, which rots the sets. I have had a great many destroyed by this means, while sets from the same stock, dibbled, were uninjured. But I do not recommend dibbling except on well-prepared light land. This should be kept clean with the hand-hoe and stirrer, and when about a foot high the potatoes should be earthed up slightly, so that a small *channel* shall be left with the stems in the middle of it. I do not like planting sets cut *very small:* I prefer them an inch and a half in diameter. I am also decidedly averse to autumn planting, as a general system; for, besides the danger of frosts and thaws, there are many insects in some soils which would leave the sets mere shells. I have not had much experience in raising seedlings; but have grown a few sown thinly in shallow drills in light vegetable mould—one root produced upwards of thirty small tubers; and to raise the largest possible crop from a given number of sets, no plan can surpass that practised by the late T. A. Knight, Esq., who is said to have raised almost incredible crops by it. His plan was, to keep the surface round the plants slightly stirred, and to add a small quantity of fresh light mould to them as their roots extended towards the outside, and to repeat this occasionally throughout the season.

I might add more on this subject, but find it impossible to improve in any respect upon the very excellent Essay of Mr. Henry Cox, in the last volume of the Royal Agricultural Society's Journal, which ought to be read by every grower of the potato. I will, however, take the liberty of adding two sorts to his list—the White Scotch Kidney, which is a great bearer in good land, resembling the Ash-leaf, but larger and of excellent quality, and the Jersey Blue, which is an immense bearer, hardy, perhaps the longest keeper, and when grown in light soil, free from core, and boils to a mass of flour.

I always avoid taking them up in wet weather; there is fermentation enough in a heap of potatoes if never so dry. I had mine last year laid up in ridges 4 feet wide at bottom; then roughly thatched with straw sufficient to keep out rain. They remained thus for three weeks, the weather being very fine; they were then carefully sorted a second time, which was more easily

* This plan produces from 8 to 12 tons per acre on my land.

done now, as the skin of the diseased ones had peeled up. The best were then put into a cool shed, lightly covered up with straw; the others were packed in ridges, covered over with dry mould, and then well thatched. They all kept well, but those in the shed the best. I had some packed with lime and others with ashes, but they were no better than those without any, which kept as well as usual, not more than two pecks of bad being found in a ton late this spring.

Certainly the best way, and I believe the most economical in the end, is to put potatoes into a house constructed on purpose for them. They are then accessible at all times, and the pickers (usually women) need not be exposed to all kinds of weather in the winter. A house upon the following plan, the owner informed me, had fully answered his expectations for the last fifteen years, during which time he had not had a peck frozen in it. It is constructed in the following manner:—Posts are fixed in a row in the ground, about 3 feet apart, 6 feet 6 inches out of the ground, to support a plate. The same is done on the opposite side, about 9 feet wide. Tie-beams are then fixed across (about 6 feet apart) from plate to plate; a doorway is framed at each end, and one in the middle. The walls are then built up outside the posts with turf and strong loam or clay, 3 feet thick at bottom, closely rammed and sloping to about 2 feet thick at top; rod-hurdles are then placed across the tie-beams, and on these bad hay or old litter of any kind is built up like the roof of a hay-rick; and when properly settled, it is well thatched over nearly down to the ground. The doors are blocked up during hard weather with litter.

As any rough posts *will do*, if sound, the cost is very moderate. This house is 140 feet by 9 feet, inside width. Probably one or two trunks, like water-spouts, passed through the roof, with caps to close down, might be useful as ventilators in a house of this size; and similar trunks perforated would, I doubt not, be of advantage if inserted in all large heaps of potatoes, especially if wet, whether in pits or houses.

Potato-house. 100 feet, 9 feet inside width.

I have omitted mentioning that I tried dipping the diseased potatoes in strong solutions, but I found that, in proportion as the disease was checked externally, it spread more rapidly within. Nothing seems to preserve them better than keeping them dry and cool.

I have at length brought this mysterious subject to a close, and hope I have sufficiently explained the nature of the disease and such palliative or remedial measures as are really useful; but I have endeavoured to be as concise as possible, knowing that most persons have become weary of the subject. Should, however, any additional information be required, I shall be happy to afford it as far as lies in my power.

May, 1846.

Supplementary Observations on the Growth of 1846.

My ash-leaf potatoes were nearly killed down to the ground by the spring frosts, but afterwards rallied and looked healthy; they, however, turned off sickly in June (which was very hot) without any appearance of mildew, and I found only one diseased tuber among them.

The Shaw, of which I had two acres growing where a potato had never grown before, were short in the haulm, and turned off by the middle of July, being nearly ripe. The skins were set the beginning of August, but, being apprehensive that, after such great heat and drought, if heavy rains ensued, they would be attacked with last year's disease, I had taken the precaution to pull up the haulm (which had several times flagged during the intense heat) before any mildew appeared, with the exception of a small portion for observation.

I first observed the mildew on the 8th of August. It commenced in the middle of a field of seven acres, on a spot where a pit had been filled in with strong clayey loam, the rest of the field being a sandy loam. A sort of bowl was formed in this place, and the haulm was very luxuriant a few days before, when my women complained that they could not get through it to cut down weeds. On looking for this spot on the 8th I was startled at the sight of a circular patch of blackened stems, the lower parts naked from the leaves having fallen from their axils, and the upper part of the foliage green and brown, and glittering with the botrytis as with frosted silver, the under surface being curled over the upper. No microscope was required to discern it this year; it was perceptible at a distance of several yards, and continued to spread in a circle up the sides of the bowl. I examined the tubers, and found the greater part of them diseased as far as the pit extended,

but no farther. I had the whole of the haulm, except a small patch for observation, pulled up without delay, as I found the Botrytis infestans, which is at least an infallible indication of the disease, had attacked some of the lower leaves slightly all over the field. On taking up the crops, the Shaw contained five pecks of diseased in 100 bushels. The blue, being later, contained 13 bushels in 350 bushels, but 10 bushels out of the 13 came from the pit and the part immediately surrounding it. On the drier parts of the field there was scarcely a bad potato. It is also very remarkable that in the grounds of my neighbours, right and left, the disease commenced in filled-up pits, and the tubers were in those parts much the worst. It was in a similar situation in the year 1841 that I observed my potatoes affected with the same disease; and a very extensive grower has since informed me that previous to his draining his fields he has sometimes lost 20 tons by the same rot in wet autumns. The blotches on the stalks I find denote the second stage of the disease, and I was anxious to have my haulm pulled up before these appeared,—for which the weather was favourable. With much wet and a close atmosphere the gangrenous process is very rapid, and the botrytis multiplies greatly; but during drying winds and bright sunshine the latter is not developed, except in very damp situations. I gathered during the dry warm weather a great number of blotched leaves, on which I could not discover the botrytis with the highest power of my microscope; but on putting a drop of water into a wine-glass and inserting the petiole, and placing the glass in a close shady place, a crop of it was produced within two days. By this means I have raised finer specimens of it than ever I have found out of doors. I inoculated the leaves of several potatoes with the botrytis by scraping the underside with my nail and rubbing an infected leaf upon them, and, if the weather were gloomy and close, it would appear in two or three days, but if dry, and a brisk wind prevailed, in an open situation, it would sometimes not grow at all.

Having kept two or three potato-plants in my greenhouse for experiment during the summer, which were perfectly healthy on the 13th of August, the atmosphere of the house being then moist, I inoculated two or three leaves of one of them, which I had also subjected to experiment in the spring, and set an infected plant taken up on purpose next to it, but up to this time, October 14, only five of the leaves and petioles, which are not more than three inches apart, are withered; the atmosphere of the house having subsequently been kept drier for the purpose of ripening grapes, with good ventilation; the vitality of the plant has a second time overcome this injury, and the rest of the foliage is quite green and healthy. Still I do not doubt that the botrytis is a very

powerful agent, under peculiar conditions of the atmosphere, in accelerating the decay of the potato-plants; but I am of opinion that it will not attack them except they are predisposed, nor spread itself except in a close humid atmosphere, for another plant kept all the time in the same house, but not inoculated, has not had a blotch upon it. On the 19th of August I observed a tomato-apple with a blotch similar to those on the potatoes, and, having placed it in my book-case, on the 30th I perceived a thick crop of Botrytis infestans upon it in full fructification, the sporidia being so distinct that I could discern the internal structure of many of them, and even the points at their summits (Fig. 3. A.). The leaves, stalks, and fruit were blotched like those of the potato, both this year and last; but although they have a somewhat greyish appearance underneath, I have never yet found the botrytis upon the leaves, notwithstanding I have placed them in situations likely to promote its growth, which seems also to negative the idea of the blotches themselves being produced by botrytis. On examining the blotch on the fruit a few days later, I found a thick crop of another (Fig. 4.) species of fungus, with globose sporidia on short stems without branches.

I have also found the Botrytis infestans growing on the inside (Fig. 5 and 6) of the tomato from which I had cut a diseased portion.

I have entered thus fully into particulars relating to the botrytis, as it has, I believe, been everywhere manifest on the potato-leaves this year, but I have seen nothing to shake my conviction that, although a powerful one, it is only a secondary agent in promoting their decomposition.

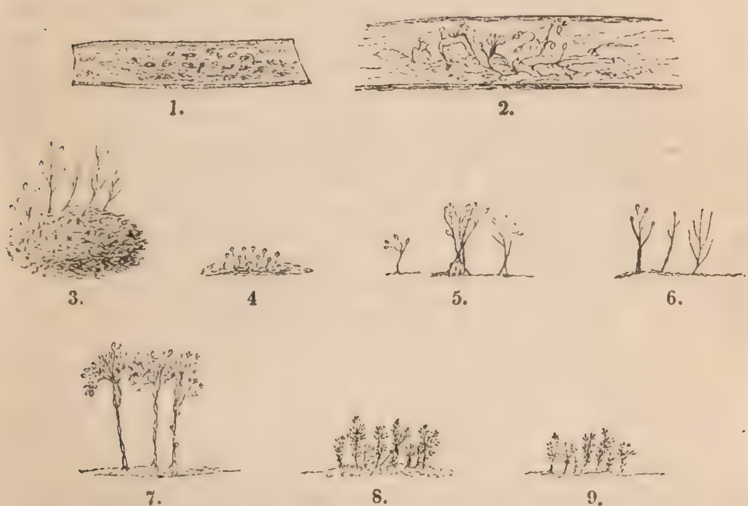
The mildew on the specks called the scab, of which I have figures, is also only occasionally developed—indeed it is difficult to find a specimen of it. The scab being a cutaneous affection, the specks are merely the result of some improper accretion being thrown off, and I suspect that the small white spots observable upon the skins of some varieties (as upon apples) denote the position of glands provided for some important purpose, and the impure fluid which escapes at these points becomes the favourite pabulum of a little dainty parasite.

I have, however, another species to notice even more minute than the Botrytis infestans, but (as it appears to me) performing an office on the underground stem at least as destructive as that species on the leaves. It has been supposed, from the fact that the underground stem has been frequently found in a scurvy unhealthy condition previous to the disease being seen in other parts of the plant, that it invariably breaks out there first. There are, however, many exceptions to this; indeed, such are the variations of latitude, soil, heat, moisture, &c., under which the plant is grown, and by which it is undoubtedly affected, that it would probably be as easy to

account for one person escaping from a malignant epidemic to which his neighbour fell a victim as to account for every phase of this mysterious visitation. But if the rusty spots on the underground stems are carefully examined, it will be found that small white specks of mildew exist between the bark and woody part, and also frequently occupy the internal tissue of the bark itself, even in a greenish state.

There are apparently two species; in an early stage being somewhat like jelly, but in a more perfect form resembling the accompanying drawings (Figs. 1 and 2), one species being not

A



1. Inside of bark, underneath a rusty spot, on underground stem of potato, showing a number of white specks of mildew in an early stage, the brown spot not having encircled the stem. Sept. 7.

2. Most likely the above mildew in a more perfect state. The sporidia, being very transparent, appeared to be filled with spores; some had burst. On inner bark of underground stem of potato. Sept. 8.

3. Botrytis infestans, on green tomato, diseased like the potato.

5 and 6. The same on ripe tomato, outside and inside of a blotch, beautifully vitreous. Sept. 26.

4. Another species on diseased tomato.

7. Botrytis parasitica, on lettuce leaves. Sept. 24.

8. White mould on underground stem of potato.

9. White mould on scab on potato, apparently identical with No. 8.

unlike that produced on the scab (Figs. 8 and 9); but I have not been able to ascertain the names of them, *if they have any.* With regard to these species I am of opinion that, like the botrytis, their proper food is vegetable matter in an unhealthy condition. I shall only further observe with respect to fungi, that many species have been unusually prevalent this autumn;

the common plantain, groundsel, peas, clover, brocoli, turnips, gourds, cucumbers, lettuces, and many other plants and fruits having been attacked, and some destroyed, each by its peculiar parasite, after being reduced to an unhealthy condition by weather calculated to depress its vital energy.*

I shall next notice the several insects with which the potato-plants have been infested, and to some of which the disease has been ascribed. Numbers of aphides which feed chiefly on the under side of the leaves, probably on the fluid contained in the glandular hairs with which they abound, appeared on the 13th of July, some of which were punctured by parasites, and from which I bred the Aphidius avenæ, and also Ceraphron Carpenteri,† which destroys the larvæ of the Aphidius. Perfect lady-birds and their larvæ were also feeding on them in considerable numbers. The Eupterix solani ‡ appeared July 20th, and multiplied very fast, for I found soon after some of all sizes as well as their eggs, which are oval, white, and ribbed lengthwise; but I could not breed them. I also found another species distinguished by black spots on the wings (Eupterix picta). Having watched these beautiful flies inserting their beaks into the leaves of the potato for a quarter of an hour at a time, and noted the places exactly, I can safely say that blotches did ensue on some of them, though not on others; and possibly their punctures might render the leaves more accessible to atmospheric injuries or even to the spores of botrytis. Be this as it may, if any insect which I have seen is accessary to the disease, I believe, from the innumerable swarms of them thrusting their long beaks into the leaves, it must be these. I afterwards found a very minute creature called Smynthurus. He is rather ugly in shape, and sometimes in colour not unlike a tortoise. He can leap well, but is not very shy, for I watched one or two of them for a long time greedily devouring some loose filaments of botrytis; these, therefore, were doing no harm. I also found the Thrips minutissima,§ but not in any quantity. This is rather shy, and the larvæ would sometimes let themselves down by a thread which they spun: they seemed to feed upon the pubescence of the leaves, as a shiny patch was often observable with the hairs closely mown off as it were by them. I also found the green

* It is well known that many plants, such as cabbages and turnips, recover from the effects of mildew after having been entirely covered with it; and this season I had some cauliflower-plants attacked as soon as they were in the rough leaf, yet, having been well watered, they recovered entirely, and produced a crop of very fine heads in November.

† Agricultural Journal, by Mr. Curtis.

‡ First noticed by me last year, when I sent specimens to Mr. Curtis, who figured it in the 'Gardener's Chronicle.'

§ Figured by Mr. Curtis in 'Gardener's Chronicle.'

bug Lygus, first noticed by Mr. Balkwill, who said the disease was caused by the acrid fluid discharged by it. I squeezed this fluid on some leaves of the plant in my vinery, and the mark is visible still (Oct. 10), but it never extended farther. I also caught a great quantity of the Altica exoleta? on the leaves, which they nibbled into innumerable holes. I found also the red spider in some places feeding on the under surface, and causing the leaf to assume a whitish appearance, as it does in cucumber and melon plants. I placed all these species upon the potato-plants in my vinery, but, with the exception of the inoculated leaves, they are perfectly healthy now (two months since, October 14). On the 23rd of July, however, I found a plant in my field, two or three of the lower leaves of which were rather sickly, and, when taken up, it had one diseased tuber attached to it. The specks which I have alluded to as being white on the skin of the healthy tuber were in this brown and filled with putrid matter, which, when removed, left a small hollow like a cup: the corrupt fluid exuding from each of these cups or glands (as I suppose them to be), it becomes the nidus for a tuft of mildew. Not seeing cause enough to account for this diseased tuber, I split the undergound stem, when I found in the inside the larva of the Molobrus (bred from diseased potatoes last year, and figured by Mr. Curtis in the 'Gardener's Chronicle'), as shown in the drawing I have made; but whether this small

B

1. Underground stem of potato, perforated and partly eaten by the larva of a fly, Molobrus fucatus; bred by Mr. Curtis amongst diseased potatoes—the stem diseased, as also the lower roots—foliage sickly. July 23.
2. Diseased potato attached to the above stem, at the + the cord rusty-brown.
3. The larva magnified.

maggot had promoted the disease in the tuber or not is more than I can say; but I think not, for the following reason:—I had a piece of potatoes, with oats on each side, which I feared the wireworm would have entirely destroyed. Suddenly, however, they recovered, and soon after many of the potatoes began to flag and

wither, and, on pulling them up, the underground stems were riddled through and through, with wireworms sticking in them, many fibres being also gnawed off by them, but the tubers were not diseased, and are sound now (December 9th). It is, therefore, my opinion that no injury the plant may receive from insects will of itself produce the gangrene, by which it is unquestionably destroyed.

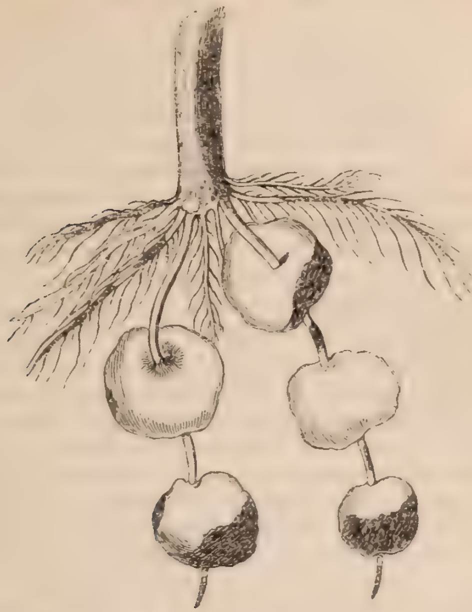
I will now endeavour to describe the progress of the disease, having had opportunities of observing it this year at an earlier period than last. It usually commences in a semi-transparent blotch on the underground parts, which is formed by brown, shiny, extravasated fluid between the epidermis and inner bark, sometimes only on one side of the stem or roots; and, if the soil becomes dry and the weather fair, it penetrates through the bark rather slowly, but progresses rapidly in a damp soil with a close humid atmosphere. I have marked several of these blotches in their transparent state as soon as formed with bits of thread, and find that, sooner or later, according to the circumstances above mentioned, they assume a scurvy, opaque appearance outside, but, by cutting through this, the shiny fluid may generally be seen within. The blotches in the tubers change in a similar manner, and the progress of the gangrene in them is accelerated or retarded by the like circumstances; the blotches on some of my potatoes last year, which were kept dry and cool, not having penetrated more than 1-8th of an inch up to the end of March, having, however, assumed a dull sunken appearance in place of their former glossiness.

Previous to my having traced the rustiness of the stems to the original transparent blotches I entertained some doubt as to its connexion with them, from the fact that the inner bark of the specimens which I had before examined was apparently healthy, and the discolouration entirely confined to the epidermis, which had become dull, dry, and wrinkled. Now, however, I am convinced that the one is the result of the other—the epidermis having lost its transparency by corrosion of the fluid, which is also withdrawn by absorption to the inner parts of the bark, leaving the outer coats nearly dry. Similar blotches appear about the same time, or soon after, on the roots and cords. Sometimes, however, the leaves are blotched first of all. I have found many very large plants with nearly every leaf and the stalks likewise blotched, the leaves being covered with botrytis, while the roots and lower parts of the stems remained quite clear; but I have never seen until the 24th of October diseased roots or cankered stems supporting healthy foliage.* Hence it appears that the

* Oct. 24. On finding many healthy-looking plants in my field (grown

disease does not uniformly originate in the underground parts, but that the plant is stricken throughout its system by an ungenial

C



Underground stem of potato, showing the isolated gangrenous blotches on the stem, roots, cords, and tubers.

or rather by a pernicious, state of the atmosphere; the effects of which, as amongst animals, breaks out sometimes in one part and sometimes in another. Owing to the extreme excitability of the plant this season in consequence of the long drought succeeded by heavy rains, a second and a third production of young tubers were formed like a string of beads—those of more recent formation upon cords thrown out by those which were older (Fig. C). Yet the shoots from the youngest were very frequently diseased, while the older cords and tubers were to the eye perfectly sound, —so strong a tendency has this disease to show itself in unconnected blotches. The rapid or slow destruction of the haulm and foliage depends upon the same conditions as that of the roots and tubers; sometimes it is effected in twenty-four hours; sometimes

from potatoes left in the ground when taken up last July) I pulled up several of them, the foliage of which was without a blemish, and to my surprise *found the gangrenous blotches just forming on parts of every root.* It is quite certain therefore that the particular part on which it breaks out is sometimes above and sometimes below the surface of the soil.

it will not be completed in six weeks. I believe it has been much more rapid in many parts this year than last.

The same disease is said to have visited St. Helena in 1840, and Ireland as well as America in former years. I am also quite certain that I had it amongst my crop in 1841, and then it was confined to a spot where pits had been filled in. To account, however, for its breaking out so universally as it has these last two years, is a task which I cannot undertake, believing, as I do, that it may arise from transitions of various kinds and degrees, which conviction I have come to, not only from the effects of my own experiments, or the bare fact that the present season differed in many respects from the last, but also from the testimony of old residents and writers of acknowledged credit in various parts of the world. From these I learn that, in parts of America and South Australia, where extreme heat and drought are suddenly succeeded by drenching rains, the potato cannot be successfully cultivated; and in others, for the same reason, it is never attempted; while in Western Australia, which is not so subject to violent changes, the potato does not degenerate. I have no doubt, therefore, although I cannot personally account for the peculiar effects of which the potato is susceptible in foreign countries, that, if the disease can be satisfactorily accounted for in a single garden, it will be found upon due inquiry that the same general cause has existed with more or less severity wherever the disease has appeared—I mean a sudden and extreme change in the state of the weather. When had we such a summer as that of 1845?—such extreme heat succeeded by long-continued gloom and chilling rains, with a temperature almost reduced at times to the freezing point? Again, in 1846, January passed without a single frost; intense heat prevailed during June and July, on the 19th of which last month my thermometer reached 100° in the shade of a tree at half-past three p.m., and 83° on another day while buried six inches deep in the earth in one of my potato-beds, being equal to the bottom heat required for the pine-apple!

On the 5th of July it was hotter in the shade, I believe, than any day on record in this country; and throughout June and part of July the thermometer only ranged from 4½ to 8° above the average for the last twenty years, according to the register kept at the Horticultural Garden; but we know not how much longer. I have also been assured by an old resident at Rio Janeiro that it has been quite as hot in Yorkshire this year as at Rio, where the potato is not grown, but imported by the packets. During the intense heat the potato-plants flagged in many places, and on the 5th of July, with the thermometer at 95° in the shade, torrents of rain descended, accompanied by an unusual storm of thunder and lightning; in the morning succeeding which, so dense an exhala-

tion* arose, that I could not discern a tree at about three yards distance—the atmosphere being upon this, as well as upon other similar occasions during the summer, extremely oppressive; and it is, I believe, certain, that this same kind of weather prevailed nearly all over England about the same time.† On the 1st of August another storm burst upon us with terrific thunder and lightning, and around the metropolis a shower of enormous hailstones; and a similar storm, with the exception of the hail, occurred again on the 5th. Here and there a trifling complaint of the disease had been previously made; but, the plants having been subject to artificial treatment, this might arise from particular causes, from which I believe the potato has always suffered; but a very few days after the last storm the outcry became general that the potato-crops were again stricken. The weather, however, became subsequently dry and warm, with a clear air favourable to evaporation, which in light friable soils well drained has rendered the injury much lighter than it would have been; but in heavy undrained soils the loss has been very serious—in some places, especially with the late varieties, amounting to total destruction of the crop. As regards a remedy, I believe the only safe plan is to prepare the ground in the autumn by draining, deep trenching, or ploughing, using a moderate quantity of manure, and planting as early in the year as the weather will admit; and should the disease attack the crop, I am certainly in favour of pulling up the haulm as soon as it is perceived, for I found many more diseased tubers beneath those roots whose stalks I left standing than where the haulm was pulled up; and had the latter part of the season been less propitious, I have no doubt the bad ones would have been in far greater proportion. It has been stated by Mr. Gilbert, of Ealing, that where he had his ground trenched two spits deep he had scarcely an unsound potato, but that where it was dug only one spit deep there were a great many diseased, although the sets were from the same stock—all partially diseased, and planted contiguous to each other. Whether they were planted at different seasons or not I am not aware; but if this plan should prove as successful upon all occasions, it is very important; as it not only shows the advantage of deep tillage, but would afford much additional employment during the winter season. It has also been said by some persons, that where they planted unsound sets the crop was uninjured; but where sound ones were used that it was as difficult to find a sound potato, as

* To this fog, and a similar one last year, the disease has been attributed by a correspondent of the 'Gardener's Chronicle,' Oct. 31.

† The county of Northampton, or a great part of it, is said to have suffered very little, and its produce supplied many London dealers in October, as I was informed by a large salesman.

in the other case an unsound one. From this many persons may conclude that they have only to provide a store of unsound sets in order to secure a good sound crop next year. But let me warn such persons, at least, not to place their sole dependence on such a rotten foundation, for I can assure them, from actual experience, (although success may have attended the practice this season, on account of the soil and weather being in a favourable state for promoting vegetation during the former part of the season,) that had the soil been harsh, and the weather cold and wet subsequently, the shoots would have been attacked with gangrene soon after they were formed, and the greater part of them would have perished. In 1841 I lost nearly an acre in this manner, the sets having been cut from tubers obtained at Tooley-street, diseased in precisely the same way as at the present time; while of the crop adjoining, from sound sets, I lost scarcely a plant.

It may appear to some persons that, because the present season has not been precisely the same as the last, the cause of the disease cannot be referred to the atmosphere. Yet so universal has the calamity been, that it seems to me almost impossible that it could be produced by anything else—for, what other subtle medium pervades the whole globe? What, short of those extremes which destroy plants entirely, is more injurious to their health than sudden and violent transitions? And have we not had these? Yes; and in so unusual a degree in both years, that every man who notices such occurrences at all, would, independently of their disastrous consequences, long remember the years 1845-6. Until these changes ensued, the crops in the open ground looked sound and healthy throughout the country. I do not notice those grown in open borders through the winter, as they are clearly exposed to too many vicissitudes, however skilfully managed; nor need I more than barely refer to a few diseased crops, which may have been produced in neglected or badly managed pits—while in adjoining gardens I have known plants in perfect health, owing to the superior skill of the gardener in protecting them from atmospheric injuries. Of such men, there are many who know that in an unsuitable atmosphere the organs of plants cannot perform their proper functions, and that, as soon as these cease, the plants themselves become the prey of gangrenous ulcers, parasitic fungi, and noxious insects. But in an inquiry of this kind we must look chiefly to the effects upon the general crop; and this, I repeat, appeared in perfect health until those changes took place, to which I have before referred; but soon after, every plant, young or old, became affected. Subsequently, however, the weather here became more moderate, and many plants which I have seen growing out of doors from this year's tubers, as well as one or two plants which I have since grown in my greenhouse, were appa-

rently quite free from disease. A similar result is recorded by Mr. C. Chapman, of Brentford, in the 'Gardener's Chronicle' of 31st of January, who planted some on the 1st of July, the produce of which were all diseased; and others on the 1st of October, taken from the same stock as the former—the produce of which proved all sound. "It appears clear, therefore," Mr. C. says, "that (probably about the end of July) there was some peculiar atmospheric change, which, combined with other things, attacked the haulm of the potato, and through that diseased the tubers." If these changes become periodical in this climate, I do not doubt that England will in a few years cease to grow potatoes to any extent; but I must say that I have never heard of any common plant being lost to cultivation from such a cause, nor do I see any probability of such sudden and extreme alterations becoming permanent in a country the climate of which is proverbially fickle.

Dec. 11, 1846. F. J. Graham,
Cranford.

XXVI.—*A Report on the Feeding of Stock with Prepared Food, and a description of the Apparatus employed.* By Joseph Marshall.

Prize Essay.

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The author of the following observations does not pretend to have discovered any new way to feed cattle; nor can the objection of novelty, the current and groundless objection of every foe to improvement, be justly urged against the system which he has adopted, and which he thinks others may adopt, if they will, with advantage. The principles here laid down have been long, though, perhaps, not generally known. All the merit which he claims is, that of having persevered in spite of friendly remonstrances, ridicule, commiseration and the like, in a course which his own reflection and calculations recommended, and which his own experience, and the larger experience of more able and scientific farmers have since proved to be successful. That success has arisen, not from the discovery of any new principles, but from the proper carrying out of principles already *known*. It has been long *known* that the use of prepared food is more wholesome and more economical than the use of raw food. Frequent attempts have been made to prepare food for stock, but either from the imperfect description of the apparatus employed, from the improper mixture of materials, from the unwholesome state in which the food has been given, or from some other cause, these attempts

have often proved failures. Why they have proved so he is not called upon to show. One tenant thrives on the same farm on which another has starved. One man feeds, and another cannot feed, cattle. Probably the same reason may have influence in both cases.

But that cattle and other stock may, with ordinary care, be fed upon food artificially prepared in the method here described; that the saving in consumption will more than repay the attendant labour and expense; that an opportunity will be thus given for consuming inferior corn of unmarketable quality at home with advantage, as the cattle thrive well upon it, and the sample taken to market is rendered better; these are facts beyond doubt.

We now proceed to state, as briefly and clearly as we can, how the operation has been conducted; to speak of the food, its preparation and effects, and make such remarks as may from time to time suggest themselves.

On the author's farm the food is prepared, and all other work connected with the system performed, by one man, except the grinding of the corn into meal, which the foreman takes and superintends, being done at a corn-mill. Dean's linseed-mill is used for crushing the linseed, and Clawdray's chopper to cut the straw.

The best artificially prepared food which we have hitherto found is boiled linseed, ground corn, and cut straw, along with some raw turnips, given at intervals. A heifer weighing from forty to fifty stones will consume, daily, two pounds of crushed linseed, boiled in three and a half gallons of water for two or three hours, five pounds of ground corn, ten pounds of chopped straw, and about eighty or ninety pounds of yellow bullock-turnips, with a little straw, not cut, placed in their racks at night. The cost of food thus prepared from the following statement, in which no charge is made for straw and turnips, and in which ample allowance is made for coal, labour, and outlay of capital, appears to be 4*s*. 4*d*. for each head per week.

Cost of prepared food for twenty-two head of cattle and three draught-horses for eight weeks in 1844 and 1845:—

	£.	*s*.	*d*.
2688 lbs of linseed, or 48 lbs. per day . . .			
192 lbs. do. not used on Sundays, deducted			
2496 lbs., or 46½ bush. of 54 lbs. at 6*s*. per bush.	13	18	0
458 stone ground oats, at 11½*d*. per stone . .	21	18	11
8 weeks wages, at 13*s*.	5	4	0
1 cwt. of coal per day, at 15*s*. per ton . .	1	1	0
Interest on outlay of 50*l*., wear and tear 8 weeks	1	5	9
	£43	6	8

Twenty-five head of stock for eight weeks, at 4*s*. 4*d*. per week,—43*l*. 6*s*. 8*d*., as before stated.

The mode in which the cattle were fed was as follows:—At 6 A.M. each beast was supplied with about forty to forty-five pounds of yellow bullock-turnips, sliced; at 10 A.M., with one pound of linseed, boiled for two or three hours, with about one and a half gallon of water, two and a half pounds of ground corn, and five pounds of chopped straw; at 1 o'clock, P.M., the turnips were repeated, and at 5 o'clock, P.M., the prepared food was repeated. At night, a little straw was placed in their racks. If any cattle had refused their mess, it was removed and given to those that had finished theirs and were desirous of more. It may also be observed, that the ground corn and chopped straw must be mixed together first, and then the boiled linseed being poured upon them, and mixed with them, may be allowed to stand for one or two hours, and given while yet warm; for if allowed to stand a few hours, the mass ferments and quickly turns sour. Hence the necessity of the strictest cleanliness in all the vessels and implements made use of.

Assuming an acre of land to grow twenty tons of yellow bullock turnips, and that they are worth about 6*l*. 15*s*. per acre, each beast will consume eighty-five pounds per day, with the prepared food; from this we may calculate that twenty tons of turnips will feed twenty beasts for twenty-six days, at a cost of about 1*s*. 8*d*. per week per head.

Again, assuming an acre of land to yield twenty tons of swede turnips, and that their value is about 8*l*. 5*s*. per acre, each beast will consume sixty-three pounds daily, along with prepared food; from which we conclude that twenty tons will supply twenty beasts for thirty-five days, at a cost of 1*s*. 8*d*. per week per head. Hence five acres of swedes, yielding twenty tons per acre, will suffice for twenty beasts for twenty-five weeks.

If, instead of swede turnips, we supply raw carrots or potatoes to the cattle, they consume the same weight of the latter as of the former, without making any apparently greater progress.

Regularity and cleanliness, highly important as they are in every system in feeding animals, are, in this method, the basis of success. Without them, every attempt must inevitably fail. I have found that the omission of this food once on a Sunday makes the cattle return to it with an increased appetite. Under this mode of feeding, three-year-old heifers increased in weight (calculating by measurement) during the time they were tied up, on an average of the whole lot, about fourteen pounds each per week. Two of them made twenty stones each in sixteen weeks. Steers consume less food, and gained weight more slowly.

The draught horses had their allowance of prepared food on

coming from work. When at constant work, and long days, each horse was supplied with about five pounds of ground oats or split beans, divided into two portions, and given morning and evening, in addition to the five pounds contained in the prepared food. During the three winter and other months in the year that my horses have had this provender, they have improved in their condition, have been free from disease, and capable of performing any work that horses kept for agricultural purposes could reasonably be required to do.

This method of feeding has been carried out by the author on a small farm since November, 1843. The increased quantity and superior quality of manure thus derived have doubled the produce of the farm. Independently of other matters, the main source from which the feeder of stock should look for remuneration is his manure heap. He cannot grow corn without manure, nor have manure without cattle. Whoever can feed the largest quantity of stock, and thus secure the most and richest manure at the cheapest rate, is best calculated to augment the produce of his farm, and thus to meet competition in the market. Up to this time, linseed cake given in large quantities along with roots has been considered to yield the best manure. But why should linseed, unadulterated, be inferior in its feeding and manuring properties to linseed, from which all its richest and most feeding matter has been extracted, and which has afterwards, in many cases, been adulterated with rubbish of any and every description? The effects of this system have been so apparent, in the increased fertility of the farm where it has been practised, as to induce my neighbours to follow my example.

Amongst them, I have great pleasure in naming John Hutton, Esq., of Sowber Hill, near Northallerton, who gave the plan a fair trial in December, 1844. The result was so satisfactory, that he has since procured an apparatus, enabling him to carry it out on a more extensive scale. He has kindly furnished me with the following report of his experiments.

T. S. Walker, Esq., of Maunby Hall, near Thirsk, and H. S. Thompson, Esq., of Moat Hall, near York, have also adopted the plan with success. Their reports I annex.

Communication from John Hutton, Esq.

On the 9th of October, 1844, Mr. Joseph Marshall produced a paper at the Northallerton Market Club, on the Feeding of Cattle with Prepared Food. I was induced, by his statement of facts, to erect an apparatus for the boiling of linseed, of the same dimensions as his own. This was first brought into operation 4th December, 1844.

Sixteen polled beasts (cows) were taken up. They were divided into two lots; each lot, consisting of eight beasts, was as nearly equal in weight and condition to the other as possible.

One lot was fed as follows, costing 6*s*. 10*d*. per head:

	s.	*d.*
Linseed cake, 3 stones, at 13½*d*. per stone .	3	4½
Turnips, 980 lbs.	3	0
Labour	0	5½
Per week, for each head . .	6	10

The other lot was fed upon prepared food:—

Linseed and ground corn	4	4
Turnips, 490 lbs.	1	6
Labour, &c.	0	5½
Coals	0	6
Per week, for each head . .	6	9½

The two lots were sold at Bedale market, on two different days; four being taken from one set of beasts, and four from the other set, at each sale. The cattle fed upon prepared food realized 2*l*. 6*s*. 6*d*. more than those otherwise fed. The time occupied in feeding them was 8 weeks.

By the first week in April, 1845, all my turnips were finished. I then put sixty head of cattle on prepared food, and found the plan to answer remarkably well. Of these, about twenty were in a very forward state; they were allowed to have prepared food after the rate of 5*s*. 3*d*. per head per week. They made great improvement, and were all sold by the 9th of July; several of them fetching 20*l*. each.

The fold-yard cattle, cows, and young stock were allowed one meal each per day of a weaker quality of prepared food, but a full quantity of cut straw. The cost was 2*s*. 4*d*. per head per week. In this way their condition was improved; and the whole of them, when turned to grass, did as well as could be wished.

My attempts in the autumn of 1845 were so satisfactory in their issue, that I put up a new apparatus on a larger scale, and having been using it since the 1st December of that year for all my cattle at Sowber Hill, which were generally in a forward condition when put up to feed. Up to this time, twenty-nine fat beasts have been sold; and seventeen more are coming on, and will be ready for sale before grass.

At present, I have twenty-eight head of cattle tied up to stall-feeding, at a cost per week per head, including turnips, of 6*s*.; twenty-four in fold-yards, costing 3*s*. 6*d*. per week per head; and sixteen cows and nine yearlings that have prepared food, at a cost of 2*s*. per week per head; and, in addition, hay of inferior quality.

I have also tried the experiment with sheep, of which I have already sold thirty. Forty sheep and sixty hogs* have prepared food twice a day, with turnips, and are doing well.

What I have seen of this system convinces me, that certainly double the quantity of stock can be maintained with the same quantity of turnips as was consumed by the old method of feeding cattle. The manure is of the best quality, and very soon fit for use. No manure I have

* Sheep under a year old.

seen has equalled in efficacy that derived from this process. Hence it is hard to fix any precise limits to the number of stock that may be maintained on a farm with a moderate supply of turnips, when this method is rightly carried out and persevered in. It seems peculiarly adapted to stiff soils, where the turnips cannot be consumed on the land. It is also applicable to light land, where only a small quantity of turnips can be taken away, as the whole of the straw by this system may be made into a much better quality of manure,

At the same time it must be remembered, that economical and fertilizing as this mode of feeding stock is, it cannot be brought into practice without sufficient capital. Nor can any system of agriculture, however good, be properly carried into effect in this country without it.

(Signed) . John Hutton.

Sowber Hill, near Northallerton,
11th April, 1846.

Communication from T. S. Walker, Esq.

Knowing that the advantages of feeding stock on prepared food will be fully detailed by some of my neighbours, who, from a longer experience of the system, are better qualified to speak of its efficacy, I shall only give the result of one winter's trial; which, however, has convinced me that the plan has a decided superiority over the old way of feeding with linseed cake or meal unprepared.

Twenty head of cattle, of various ages,—steers, cows, and heifers,—generally in a low, and some of them in an unhealthy condition, were put up to feed. The improvement of all was most satisfactory. Part of them were killed in the neighbourhood, and turned out quite equal to the expectation of the butchers.

As to feeding young stock with this food, in preference to hay and turnips in large quantities, I submit the following statement:—

Thirteen calves, varying in age from six to fourteen months, principally well-bred short-horns, in very low condition, were turned into an open yard with a good shed, about the last week in November. Straw (principally wheat and barley straw) was allowed sparingly, and a moderate quantity of turnip-tops were given during the early part of winter. Afterwards, about twenty-four pounds of turnips were given to each daily. In addition to this, prepared food was given of about the value of 3*d*. per head per day. The improvement of the youngest of them was very rapid, in spite of the disadvantages of being chased from their food by the older calves. The progress of the older calves may perhaps be best proved by the fact, that butchers wish to buy them now at the highest market-price. I give my decided opinion, that had they been fed with good hay, and an unlimited supply of turnips, they could not have been brought to so high a state of condition in the same time.

About twenty head of cattle intended for grazing, recently purchased, have had prepared food, and their rapid improvement has attracted the notice of all who have seen them.

In conclusion, I feel assured that if, instead of the present restriction in some agreements with tenants, by which they are debarred from growing linseed, encouragement were given to all tenants to grow lin-

seed, to be consumed on the farm in feeding and rearing stock, at least two-thirds of the grass-land, now most unprofitably used in growing hay, might be much more profitably devoted to grazing and rearing cattle, for which the rapidly-increasing population of this country always furnishes a demand. The superiority of the manure produced from stock fed in this manner over common farm-yard manure no one will deny; and it is difficult to assign limits to the produce of the arable land of this country, if all the straw were judiciously consumed.

Communication from H. S. Thompson, Esq.

Dear Sir,—I have great pleasure in sending you the result of my trial of your method of preparing food for cattle. I have not had time to make a long trial, but I have taken some pains to make an accurate one. My previous system having been found to work well, I determined to give it a fair chance against the new one; and I accordingly selected two of the most thriving of a lot of twelve bullocks, of nearly the same age and condition, and fed them for the first month on the food I had been in the habit of giving, viz., swede turnips, linseed cake, and bean meal, in the proportions stated below. Two others, of nearly equal weight, had their food prepared according to your directions. All four were weighed at the commencement of the experiment, viz., April 11th, 1846. Their weights are given in Table No. I. The numbers are the numbers of their stalls, to prevent mistakes. Nos. 8 and 9 were fed in the new way. Nos. 12 and 13 in the old. They were weighed a second time on the 15th of May.

Table, No. I.

No. of Stall.	Live weight, April 11. st.	lbs.	Live weight, May 15. st.	lbs.	Increase in weight. st.	lbs.
8	83	8	88	4	4	10
9	79	8	85	1	5	7
12	81	0	85	2	4	2
13	85	0	89	0	4	0

Thus it will be seen that the bullocks fed on the old plan gained 8st. 2 lbs. in five weeks, and those fed on the new way gained 10 st. 3 lbs. in the same time. As I was convinced that the two bullocks which had made the least progress were, nevertheless, the most thriving animals, I for the next month fed all four alike, viz., on swedes, mangold-wurzel, and your prepared food. The results are as follows:—

Table, No. II.

No. of Stall.	Live weight, May 15. st.	lbs.	Live weight, June 15. st.	lbs.	Increase in weight. st.	lbs.
8	88	4	92	4	4	0
9	85	1	90	12	5	11
12	85	2	92	7	7	5
13	89	0	96	0	7	0

The impression that the bullocks No. 12 and 13 were better thrivers than Nos. 8 and 9 was, it will be observed, fully borne out when the four were fed alike, the latter two having made 14 st. 5 lbs. in the thirty-one days, and the former only 9 st. 11 lbs. If we compare the increase of weight of the two bullocks, Nos. 12 and 13, when fed on the old plan

for thirty-four days, viz. 8 st. 2 lbs., with the increase of the same bullocks when fed on your plan for thirty-one days, viz., 14 st. 5 lbs., the superiority of this method is very apparent.

Let us next compare their cost.

First Method of Feeding.

	s.	d.
10½ lbs. of linseed, at 7*s.* per bushel, of 56 lbs. or 1½*d.* per lb.	1	3¾
35 lbs. bean-meal, at 1*s.* per stone . .	2	6
100 lbs. of coal daily, at 14*s.* per ton, or 4*s.* 5½*d.* per week, for twenty bullocks, or, for each, per week	0	2¾
Extra wages 4*s.* per week, or 2$\frac{4}{10}$*d.* per head, say	0	2½
Cost per head per week . .	4	3

Second Method of Feeding.

21 lbs. of oil-cake, at £10 per ton, or 15*d.* per stone	1	10½
21 lbs. bean-meal, at 1*s.* per stone . . .	1	6
20 stone of turnips extra, say . .	0	11½
Cost per head per week . .	4	4

By the above calculations it appears, that the cost of the two methods is about the same. I have, however, to observe, that, to avoid raising the expectations of those who may wish to try your plan too high, I have, throughout the two estimates, favoured the old system rather than the new. The price of the linseed is decidedly above the average. Coal can, in most situations in the north, be had for less than 14*s.* per ton; and the charge both for coal and wages would be lower per head, if I had made my calculation for forty bullocks instead of twenty. On the other hand, had I, in the second estimate, valued the oil-cake at what I have given, on the average, for the last five years, viz., 11*l.* per ton (for the best English-made cake, including carriage), and estimated the turnips at 10*s.* per ton, instead of 7*s.* 6*d.* (a very low value), the comparison between the two plans of feeding would have been very decidedly in favour of the new system, in point of economy.

Before leaving this part of the subject, I would wish to remark that though I have given an estimate of the cost of the food for seven days, I really only use it six days out of the seven, as, if the steamer were kept going on the Sunday, the men in charge of the cattle would have to work as hard on that day as on any other day of the week. I consequently substitute linseed cake for the prepared food on Sundays, and am of opinion that this slight change of food is rather beneficial than otherwise. The cost of the linseed cake is so nearly equal to that of the prepared food, that I have not thought it necessary to make any difference in the calculation on that account.

I have now given you the result of my trial of two different systems of feeding, and also estimates of their cost, and will next endeavour to

answer a question which has already been frequently put to me, viz.: What are the peculiar advantages attendant upon this system, which should induce farmers to incur an expense of 50*l.* (price of apparatus and cost of fixing) for the sake of introducing it? One of the principal advantages is, that the animals make greater progress at the same cost. In all the instances that I have heard of or seen, the cattle treated in this way have fed *unusually* fast. In my own case this was very striking. The twelve bullocks mentioned above, were, in March, taken lean from the straw-yard; quite unfit, in fact, for tying up to feed, except by way of experiment: yet, they made such rapid progress that some of them were sold to the butchers at 7*s.* 3*d.* per stone, at the end of May; and the last were sold the third week in June, in good killing condition. One of the main causes of this rapid progress is, I conceive, the perfect state of health the animals enjoy. Linseed oil is a mild purgative, and when combined with meal, especially bean-meal, the bowels and skin are kept uniformly in a state of health, which, I think, cannot be surpassed, and which I never before saw equalled.

Another reason which appears to conduce much to their thriving, is, that the food prepared in this way approaches so much more nearly to the natural food of the animal. In grass, and other green food, we find a very small per centage of nourishing ingredients combined with a large proportion of woody fibre, water, and other matters which are not fitted for assimilation by the animal, and are rejected as useless after the nourishing parts have been extracted by digestion. These apparently superfluous matters have, however, very important uses; one of the most striking of which is to give bulk to the food, and, therefore, distension to the stomach. If the stomach is not moderately filled by a meal, those muscles are not called into active exercise which tend so much to promote healthy digestion, by keeping the food in constant motion; and accordingly, we find, that if we supply a feeding bullock with cake or meal, which, though highly nourishing, lies in a small bulk, the animal will, if not supplied with a sufficiency of other food, eat a portion of his litter, old thatch, or almost any other vegetable matter, however unpalatable, to satisfy that craving which an empty stomach is sure to produce. Though, however, an animal will swallow a certain portion of food for which he has no relish, rather than lie down with an empty stomach, he will not fill himself properly unless he likes his food; and, on the other hand, if an unlimited supply of favourite food be furnished to him, he will take it in quantities injurious to his health. The following is a case in point:—

Before tying up the twelve bullocks, mentioned in a former part of this letter, I desired that they might have a fair allowance of swede turnips given them for a short time, lest a too sudden change of diet should disagree. They, accordingly, had four or five stone of swede turnips per head, daily, and with this they did well; consuming, at the same time, a considerable quantity of straw. After having this quantity for a week or two, I increased their allowance of turnips; and, finding their appetites kept pace with their increased allowance, I ordered them as much as they would eat. At the end of about a month, I found that they were each consuming about fourteen or fifteen stone of turnips daily, and that they ate no straw. This was continued for a short time, in

consequence of my apparatus for boiling linseed not being completed as soon as I had expected. And I found, that though the turnips were sound and good, the animal's bowels began to be affected, their coats grew rough and staring, and the purging increased to such an extent, that without a change of meat, I have little doubt dysentery and inflammation of the bowels would have been the result. The same turnips, when given in so limited a quantity that they were obliged to eat a certain quantity of straw to fill their stomachs, agreed perfectly well; but when they could fill themselves with turnips they refused the straw, and became ill in consequence. This might, probably, not have occurred had the straw been very good, which it was not; but it is a good instance to show the importance of a well-regulated diet.

As soon as they were fed with the prepared linseed, and had but fifty pounds of turnips per head per day, they at once recovered their health. Other instances also have come under my own observation, where severe purging has been brought on by improper diet. I have seen it produced by mangold-wurzel, by carrots, and by potatoes when given in large quantities.

Another advantage of your system is, the great saving of turnips. To keep a farm in a high state of fertility, it is, on almost all descriptions of land, necessary to fatten cattle in yards during winter: and as turnips and other root crops are indispensable for this purpose, any system which economizes their use is equally important to strong and light land farms; as, in the latter case, it leaves a greater proportion of the turnip crop to be consumed on the land by sheep, and on the former a larger number of cattle can be fed on the same breadth of fallow-crop; which, to those who know the difficulty of catching a season for even a few acres of such crops on really stiff land, will be felt to be a point of material importance.

Allow me, in conclusion, briefly to point out the many points of resemblance between your prepared food and that obtained by a grazing bullock in a pasture. The grass is in short lengths, and requiring little mastication before swallowing; it contains much water, and nourishing ingredients are mixed with a large proportion of what may be called neutral matters to give distension to the stomach. In the artificial food, by using chaff or chopped straw, you also save the labour of long mastication, and furnish the neutral ingredients which give the required bulk. The boiled linseed and meal, intimately mixed with the straw, furnish the nutritive matter, and give an agreeable flavour to the whole; a sufficient quantity of water is also thus supplied, and the warmth is artificially furnished, which, in summer grazing, the temperature of the air supplies. The parallel is very complete, and its success is such as a close imitation of nature usually ensures.

I beg to state, that as I intend (D. V.) to have your system in full operation during the whole winter, any brother farmer who may wish to see it at work will be heartily welcome to do so at my farm, whether he wishes to take a hint, or merely to examine and criticise.

I am, dear Sir,

Yours truly,

H. S. Thompson.

Moat Hall, York,
Sep. 14th, 1846.

In the winter of 1842, before my intention was drawn to the boiling of linseed for feeding purposes, I had fourteen head of cattle, and other stock, on food artificially prepared as follows:— thirty-five to forty pounds of thoroughly steamed potatoes, with four pounds of ground corn, and six pounds of cut straw, were given to each beast daily, with a little straw in their racks, morning and evening. This food was prepared and given warm twice during the day; half the above-mentioned quantity at a time; a supply of water was also given them, when eating the prepared food. The potatoes were bought and delivered upon the premises, at 1*s*. 1*d*. per bushel of eighty pounds; the ground corn at 1*s*. 1*d*. per stone; and during the last eight weeks, the cattle consumed a ton and a half of linseed cake, at 8*l*. per ton. To these items, labour, coal, &c. must be added. At the time these cattle were sold, beef had advanced in price 4*d*. per stone; and they left me a heap of manure valued at 5*s*. per cubic yard, when it was carted out in September, 1843, to pay for the straw, which, with the exception of two tons, had been purchased.

The quantity of manure produced by this method is small, when compared with that which arises from prepared linseed, when given with raw turnips in the manner already described. Nor does it appear that the cultivation of potatoes for the feeding of stock can be generally profitable. But in districts where potatoes can be grown and sold at a remunerating price, this mode of consuming such as are not marketable for domestic purposes is far preferable to giving them in a raw state.

I gave some of this food to half-bred ewes with lambs, from the early part of March, until grass came,—they ate greedily, and milked well upon it. The grass-land on which they were fed still retains a luxuriant appearance. This description of food, like the other, if allowed to stand three or four hours, or even less, turns sour and is unfit for use; and when given to horses in this unwholesome state, they are, until accustomed to it, frequently attacked with the gripes. This the author has frequently witnessed at the Bierley Iron-Works, where the horses have been fed with steamed potatoes, bean meal, and chopped straw, for twenty winters in succession.

To describe the apparatus used in preparing food for stock is the province of an engineer rather than a farmer. The difficulty of giving a description at once short and intelligible is not diminished by the fact, that most agricultural readers (I speak of those in my own neighbourhood) are utter strangers to steam and its effects. It is, therefore, intended to give nothing here beyond a clear and concise outline, leaving such readers as may wish to make further investigation to consult engineers, or others competent to execute contrivances of this sort.

The boiler and apparatus used by myself and some of my

friends came from the establishment of Messrs. Barker, Cutler, and Eastwood, Waterloo Iron-Works, Bradford, Yorkshire. Their workmanship has given great satisfaction.

A waggon-shaped wrought-iron closed steam boiler, about 3 feet 6 inches long, 2 feet 6 inches wide, and of proportionate dimensions, is set in brick-work over a furnace, with grate and door attached, with a circulating flue, built with fire-bricks. The boiler is supplied with water from a cistern, containing about 250 gallons. The same cistern also supplies water with which the linseed is mixed for boiling. By means of fuel, the steam is raised to a pressure of about four pounds on the square inch; that being the pressure best suited for our purpose. But when that pressure exists, the boiler will not supply itself with water (which it ought to do), unless the water in the cistern be elevated twelve feet above the water in the boiler; and in most situations for raising water into a cistern so elevated, a force-pump is required, and is found to be the most effective and cheapest instrument that can be employed for that purpose. The boiler should have a safety-valve, a steam-gauge, and a water-gauge. A pipe of three-quarters of an inch bore conducts the steam from the top of the boiler to the vessel containing the linseed, which we come to next.

At such a distance from the boiler as is most convenient (perhaps two or three yards from it) is fixed a circular cast-iron pan, about 30 inches wide, and 26 inches deep, having a rim or flange round its outer edge 3 inches wide; inside this is placed a smaller pan, 28 inches wide and about 24 inches deep, also having a rim or flange round its outer edge, but so much wider than the flange of the other pan, that when the smaller pan is placed inside the larger one, the outer edges of the two flanges are commensurate. The two flanges are jointed with bolts and cement, so as to be steam-tight. The two vessels thus fitted together, may not inaptly be compared to a small hat placed inside a large one. This being done, there is between the outer surface of the lesser and the inner surface of the greater pan a small space for the steam to be conducted from the boiler by the aforesaid pipe; in which is placed a stopcock for increasing, diminishing, or entirely cutting off the supply of steam. The water generated by condensation in the interval between the two pans is drawn off by a small tap in the bottom of the outer pan. The smaller pan is made to contain about 40 gallons, in which the linseed is prepared. Such a pan filled with water will boil, in about 30 minutes, enough linseed * for a single meal for 24 head of cattle.

* The linseed should be crushed before boiling, but not reduced to meal. Peas, beans, and Indian corn should be ground into meal, otherwise they pass through the animal whole and undigested. Other grain should be either crushed or ground.

Linseed may be boiled three times during the day in the same pan; twice for the feeding beasts, and once for the store beasts; consuming about 1 cwt. of the best coal. By this method, linseed never burns to the pan; boiling over is prevented; and constant attendance during the process unnecessary.

For steaming potatoes, the steam passes through a pipe from the boiler into a closet formed of cast-iron plates, having a lid fitted up to be steam tight, and having a false bottom perforated with holes, through which the condensed steam passes from the potatoes to the true bottom, whence it is discharged by a small tap inserted for the purpose. For getting the potatoes out of the steamer, a loose door 9 inches square, in the low part of one of the sides, is necessary, from which the potatoes are discharged upon the floor, or into any vessel adapted to receive them, and may be taken thence to their destination.

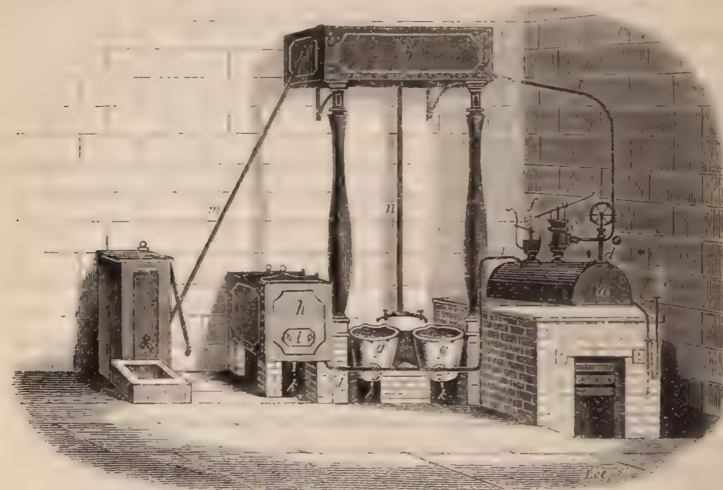
The steaming of hay or straw, when cut, is most easily effected by having the steam conducted into the lower part of a large box, so as to allow of the hay or straw being trodden down into a firm mass, before the steam is admitted to it. The steam being turned on, as soon as it has found its way through, the operation has been continued long enough. It is not, perhaps, generally known, that mouldy hay, having undergone the action of steam, loses all its noxious properties.

The expense of the apparatus described, for boiling linseed and steaming potatoes, would be 40*l.*;—this does not include carriage, or men's expenses from home when fixing it. An extra double pan with taps, would be 5*l.* 10*s.*, and if a potato-steamer be not attached, the cost would be reduced 5*l.*

Many objections, and some of them plausible enough, may no doubt be advanced against the system just described. In opposition to these, nothing will be offered beyond the statement of facts and figures already given. Not that arguments are wanting on our side of the question; but because all reasoning would be thrown away upon one who rejects the evidence of the foregoing facts. Experience has taught the writer, that men of strong prejudices are convinced by no argument whatever—no, not even by the testimony of their own senses. There are persons who have actually seen the cattle feeding on this system, have watched their progress, and have had satisfactory answers to every inquiry by which such progress was made, and have at last gone away convinced the whole scheme was a delusion. Others more charitably inclined to give their neighbours credit for veracity and common sense, have witnessed the same things, made the same inquiries, have consequently adopted the system, and been perfectly satisfied with its success;—and so will every one else, who shall set about the undertaking with a persevering and unprejudiced mind.

In conclusion, I beg to thank those gentlemen who have favoured

me with the result of their experiments, and more especially for their kindness in allowing me to state, that any person who may be desirous to see the system carried out, may have permission to do so on their respective farms; and it will give me great pleasure to do so likewise.



An Apparatus for preparing Food for Stock.

a. Wrought iron-closed steam boiler.
b. Cistern to supply the boiler and double pans with water.
c. Valve which regulates the supply of water to the boiler.
d. Water gauge.
e. Safety valve.
f. Steam gauge.
g. g. Double pans for boiling linseed.
h. Potato-steamer.
i. Pipe which conducts the steam from the boiler.
j. j. j. Taps which regulate the steam.
k. k. k. Taps which allow the condensed steam to escape.
l. Door for taking out the potatoes.
m. Pipe from force-pump.
n. n. Taps which supply the double pans with water.

Holme Lodge, Bedale, Yorks. JOSEPH MARSHALL.

XXVII.—*Observations on the Natural History and Economy of the Insects affecting the Peas and Beans, including Weevils, Maggots, Bees, Plant-lice, Grain-beetles, Moths, and the Mole-cricket.* By JOHN CURTIS, F.L.S., Corresponding Member of the Imperial and Royal Georgofili Society of Florence; of the Academy of Natural Sciences of Philadelphia, &c.

PAPER XII.

MILLIPEDES.

PEAS are subject to many casualties, arising from atmospheric changes and the attacks of insects. A similar mildew to that which affects turnips and rose-leaves, often renders the crops very

sickly, and then they fall an easy sacrifice to the insect tribes. If the season be cold and wet when early peas are committed to the earth, they frequently are infested by the Millipedes,* which eat into the softened and decomposing seeds; and even if they have sprouted, few of them are able to struggle through the soil when thus weakened, and the winter and early sown crops are consequently lost to the grower.

Pea and Bean Weevils.

The next enemy these crops have to encounter are small beetles called Weevils, which either destroy the plants as fast as they push above the surface, or nibble the leaves and notch the edges when they have expanded. Most farmers are very imperfectly acquainted with the economy of these insects, and it was a long time before gardeners could be convinced that it was a Weevil which caused them so much anxiety. Some very naturally accused the sparrows: traps were set for rats and mice; lime strewed for slugs and snails; and toads were encouraged to extirpate the woodlice; but still the crops kept disappearing, as none of these precautions affected the wary enemy in his coat of mail. There were, however, both gardeners and farmers, whose close attention to the operations of nature, united with steady perseverance, which generally leads to the truth, who eventually succeeded in detecting the real cause of the mischief.

In favourable seasons the Weevils make their appearance at the end of March; but April is the month when they are most destructive to the pea-crops, and one then finds that healthy shoots are daily, if not hourly, disappearing in a most marvellous manner, without any apparent cause, so that spaces of a foot in length, and sometimes the entire rows, are lost, or the few that may be left are so weak that the produce can be reckoned of little value. The year 1844, if I may judge from the number of communications transmitted to me, appeared to be well suited to these Weevils, which were actively at work in thousands in the vicinity of Hertford at the end of March, continuing their operations for a fortnight, and entirely eating off the second and third sowing, when the plants had grown from two to four inches high. At this period of the year they issued from the ground from 9 to 10 o'clock in the morning, to feed all day upon the peas: and they retired under the clods of earth on the approach of evening. They were equally troublesome at Stafford the first week in April, when they ate off the early peas; and in the Isle of Wight these Weevils were not less destructive, for there they attacked the beans as well. On the 30th of the same month I received from

* Iulus pulchellus and Polydesmus complanatus, Royal Agric. Jour., vol. v. p. 228.

Mr. Pusey an interesting account of this beetle, communicated by Mr. Robert Baker, stating that some garden marrowfat peas were drilled early in February, which were retarded in growth from the cold north-east winds and wet, and destroyed by the ravages of this insect, which notched all the leaves (pl. Q, fig. 6), and in many instances entirely defoliated the stem (fig. 7). It most abounded on light turnip-soil. Mr. Baker correctly observes that "it is exactly the colour of the soil, and very difficult to detect, as upon the approach of any one, it falls down suddenly from the pea, and lies motionless for some time afterwards, as if dead: but if any one looks attentively forward a few yards, they may be observed in scores sitting upon the edges of the pea-leaves and gnawing away earnestly, with appetites as voracious as the Turnip-fly, and almost as destructive in the result." From the same source we learn that "they do not attack the common hog-pea so vigorously as the garden varieties, but the marrowfat and early peas suffer most; and such have been its destructive effects this spring, that nearly all my garden crops are destroyed by it." This was corroborated by the fact that the maple-grey peas nearly escaped, whilst the remainder of 8 acres in the same field were obliged to be ploughed up. What has occurred at Hertford since Mr. Webb wrote to me I have not been informed; but at the beginning of May in the following year, the Weevils were committing dreadful havoc with crops of peas and beans in the neighbourhood of Ware.

It is somewhat remarkable that this beetle, named *Curculio lineatus*, commences with the peas in March; then it affects the broad beans to such an extent, that I have not been able to find a single leaf in a field of many acres which has not been notched as much as the one represented in the plate (fig. 8); and in August, and until the close of the autumn, its ravages are transferred to the crops of clover and lucern. On the 18th of that month, 1843, I received a communication from Mr. C. Parsons, of North Shoebury Hall, Essex, which is too valuable to be passed over. He says, "I enclose you a beetle, very destructive in these parts to the young plants of clover, lucern, &c.; so much so, as often totally to destroy whole fields, and especially those of lucern (*Medicago sativa*), which they attack in such a way, that for several years past no one has been able to obtain a full plant, although going to the expense of sowing the land two or there times over. The damage is attributed by our farmers here to the Turnip-fly, and the habits of these little Weevils render it in the spring of the year exceedingly difficult to detect, as the moment one approaches near, down they fall upon their backs amongst the clods, and remain motionless with their legs folded up. I have searched a long time in vain for them in fields where

they were committing their ravages, in order to convince my neighbours what they were indebted to for the loss of their crops. At this time of the year they are readily enough obtained, as the peas, beans, and other Papilionaceous plants often swarm with them. I have a field of peas that does so at this time, the remaining leaves of which they have completely riddled; and when a person walks in amongst them you may hear a pattering like rain upon the leaves, occasioned by their dropping down. I last year sowed a small piece of lucern in July, that was untouched by them: now, whether at that time they are absent, or whether there is any interval between a first and second brood of them, would be very desirable to know, as we might then perhaps steal a march upon them."

Two years previous to this, viz., the 15th of September, 1841, Mr. William Trenchard transmitted me the following instructive observations from Marsh Farm, near Sherborne, Dorsetshire, which carry forward the economy of the Weevils several weeks later:—"Walking along the headland of a field of broad-clover, from whence the barley had been carried about a fortnight, I was surprised to see that throughout, for the width of four or five yards from the hedge, the plant was very much injured, and in many parts quite destroyed, from having been bitten apparently by some insect. Nearly every leaf was eaten round the edges, and so deeply were they indented, that those parts of the leaf not eaten are withered from the sap not being able to ascend. Curious to know by what animal such ravages could have been made (for I suppose the headland is more than half an acre), I examined the clover to discover the depredator, but for a long time unsuccessfully, until at length having stood quite still and watched the leaves intently for a considerable time, I ascertained that it was done by a number of small brown Beetles, which immediately, on moving near, hid themselves by getting under the leaves, and on a nearer approach they let go their hold altogether, and fell to the ground as if dead, but immediately recovered and crept among the roots of the clover, where they remained until all was again quiet. Being so exceedingly shy, it was a long time before I could see any of them actually eating, but by perseverance I eventually succeeded in observing several. They attack the edge of the leaf, holding it steady between their legs, whilst they eat down from top to bottom like a Silkworm. To give some idea of their numbers, when I moved the clover with my hand or foot, they fell off by dozens." On the 14th of October, Mr. Trenchard again wrote to say that since his last communication "the Beetles have considerably extended their depredations in the field alluded to; but I do not see they have done any injury in the other fields, though in every one of broad-clover there are

many leaves bitten, apparently by slugs, but I have no doubt really by these insects."

It still remains to be ascertained where the eggs are deposited: this operation must take place, one would imagine, in the summer or autumn, unless the Weevils hibernate, as they are ready to take the field in the early spring. and in April they abound on the broom and furze in Norfolk, Surrey, &c. It is equally remarkable that we are ignorant where the larvæ feed; but my friend Mr. Spence has informed me that, owing to the crops of beans in Yorkshire suffering from galls found upon the roots, there is some reason to believe that they are the nidus of the larvæ of *Curculio lineatus*, or an allied species. I have, however, examined the bean-roots where the Weevils are abundant in this country, without discovering any of the galls; yet I hope this notice may lead to a more extended examination than I have been able at present to make, relative to such an important point; for until we are in possession of the early economy of the insect, it is to a certain extent hopeless to find a remedy.

These Beetles, or Weevils, are of the ORDER COLEOPTERA, belonging to the FAMILY CURCULIONIDÆ, which embraces some of the greatest enemies the gardener, farmer, and maltster* have to deal with. The species before us was called by Linnæus CURCULIO, but is now comprised, with about twenty others inhabiting this country,† in the GENUS SITONA, and has been described as—

1. Sitona lineata, *Linnæus*, the Striped Pea-weevil (fig. 1; fig. 2, the same magnified). It is more or less of an ochreous or light clay colour, elliptical in form and convex above, punctured and clothed with minute scales, and when these are worn off by age or accident, the beetle has a black shining surface: the head (fig. 3, in profile) is deeply punctured, the scales in some lights having a bright coppery tint; it is elongated; the face is concave, with a channel down the centre, and forms a short stout nose which is notched, and at the extremity the mouth is placed; this comprises 5 pieces, 2 strong black mandibles for biting, notched on the inside (fig. 4, *b*); 2 maxillæ below them, the inside ciliated with spiny bristles, the outside producing each a short stout feeler composed of 3 joints, the 2 first subquadrate, the last oval (fig. *c*); between the maxillæ is placed the chin (fig. *d*), which is tridentate with two smaller triarticulate feelers, the basal joint is very stout, the 2nd semiovate, the 3rd short and very slender; the eyes are lateral, prominent, orbicular and black; below them on each side is a deep angular groove to receive the 2 antennæ or horns, which are inserted towards the tip of the nose; they are of a tawny colour, brownish at the extremity, which forms a spindle-shaped club; they are 12-jointed, the 1st joint very long, clavate,

* Royal Agric. Jour., vol. vii. p. 95.

† Curtis's Guide to an arrangement of British Insects, 2nd ed., Genus 375.

and forming an elbow with the remainder, 2nd longer than any of the following, the succeeding 6 decreasing in length from pear-shaped to oval, the remainder forming a 4-jointed club; the apical joint minute (fig. 3, *a*): the thorax is deeply punctured, broader than the head towards the base, the sides being convex, and three ochreous lines are formed by the scales down the back; the scutel is minute, and whitish: the wing-cases are broader than the thorax, elliptical, rounded at the apex, finely punctured, with 10 punctured striæ forming stripes, alternately of a light and darker clay tint: the 2 wings are very ample, and folded beneath the elytra; the 6 legs are ferruginous, short and stoutish (fig. 5); the thighs are thickened, but contracted at their tips, and black at the middle, the shanks are narrowed at the base; the tarsi or feet are 4-jointed, basal joint pear-shaped, 2nd obtrigonate, 3rd bilobed, all cushioned beneath except the 4th, which is long, clavate, and terminated by 2 small claws. *Obs.*—These Weevils vary greatly in size and colour, some showing the stripes distinctly, whilst in others they are scarcely visible, and in old worn specimens they are more or less black and shining.

Another species of the same genus often participates in the ravages exhibited by the peas. It is upwards of thirty years since I saw in Norfolk a bed of peas eaten off by this Weevil, called *Curculio* or *Sitona crinita*. A correspondent of the 'Gardener's Magazine'* also thus records its depredations:—"They appeared in great numbers with the warm weather at the end of March, 1830, on some rows of peas about 2 inches high. The peas are now only fit to be dug in. They feed only by day, when the sun is bright, five or six of them being on each plant. When I go near the row, they fold themselves up and drop down, some on the ground and some in the axils of the leaves, where they lie for the space of a minute, appearing like small bits of earth. I have never seen them fly, but they run very quick. I have upwards of 300 feet of row, the greater part of which is worse than the specimen sent, and none better."†

2. Sitona crinita of *Olivier*, the Spotted Pea-weevil, is identical with the *Curculio macularis* of Marsham (fig. 9; fig. 10, the same highly magnified). This insect is generally smaller than *S. lineata*, but it so exactly resembles it in form that I need only describe its colour. It is black and shining, clothed with greyish or rosy-coloured scales and short hairs; there is a pale line over each eye, and 4 dark stripes on the thorax, leaving a pale dorsal and two lateral stripes: the elytra are rather rough, with short bristles behind; the interstices formed by the 10 lines of punctures are more or less spotted irregularly with black: the horns and legs are the same colour as in the other species.

From the imperfect and slender data relating to insects connected with agriculture, it is frequently difficult, if not impossible,

* Vol. vi. p. 615.

† Communicated by Mr. W. P. Vaughan, Archdeaconry, Brecon.

to form any opinion as to the simultaneous or periodical appearance of the different species; and with regard to these Weevils, all that can be stated is, that certain seasons seem to favour their multiplication, and others to check it. It is evident that if not checked there is not a crop, whether in the field or garden, that would escape destruction; and this check, probably in every instance, might be traced to the agency of other insects, especially parasitic species, which I have so often shown are destined to the service of man. I have already alluded to the universal spread of these Weevils in 1844; I well remember that in April and May I could not find a pea-field where the lower leaves of some plants were not eroded, the beans were equally marked; and Mr. Webb * in his letter said, "it is not only incredible that this little beetle should be capable of doing so much mischief, but it is singular that for the seven previous years I had never failed in producing crops of peas in the garden of Sir William Horne."

Ignorant as we are of the early stages of these Weevils, the only remedies we can at present apply will be in destroying or annoying them in their beetle state, and from their horny shells and power of contracting and protecting their members, it is difficult to find any application that will extirpate them without injuring the plant. For the garden, I should recommend the tarring or painting two strips of canvas, and placing one on each side of a row of peas early in the morning, and two or three hours after, by shaking the plants, the Weevils would fall down and be held fast by the adhesive surface. This might be repeated several times each day, until it would be seen that their numbers were sufficiently reduced to secure the crop. Of course the painting or tarring must be repeated whenever it is too dry to fix the objects falling down.

Neither soot, wood-ashes, nor lime will injure the Weevils, we are informed and can readily believe; yet by dusting over the peas early in the morning with any or all of these powders, whilst the leaves are damp, their food will be rendered so unpalatable that the enemy will be driven to forage elsewhere; and if a row of peas were sown near, which was left undusted, the beetles would resort thither, and when it was clear by the erosion of the leaves that the plague was congregated there, boiling water poured along the line would eradicate them, and thus the principal sowing might be saved; or the tarred canvas might be most efficiently employed, if that plan were preferred. Mr. Baker has found harrowing or hoeing beneficial when a field of peas is attacked by the Weevils. It should be done whilst the dew is upon them, that the earth may adhere and make the plants un-

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* Vide p. 2, antecedent.

palatable; and he says he has found this one of the most successful modes of checking the ravages of the Turnip-fly.

Maggots of Flies in Pea-leaves.

When the plants have attained a good growth, one sees on the leaves little faded patches, with a minute brown speck in the centre (fig. 11, *e, f*). On examining these spots with a glass, it is at once clear that they are the little brown pupæ of a fly, the same as those which infested the turnip-leaves, the larvæ feeding on the parenchyma or pulp. As they have been already described in this Journal under the name of *Phytomyza nigricornis,* I need only refer to my Report for their history.*

Maggots of a Moth in Peas.

When the peas have escaped the enemies we have described, or survived their attacks, they are not safe from the inroads of other insects. In wet seasons, as in 1845, the pods became diseased and thickened in August (fig. 12), and on opening them I found only one or two abortive peas (fig. *g*), with numbers of little white maggots adhering to the inner surface (fig. *h*). When magnified these larvæ are found to be composed of 13 segments, including the head, which is small (fig. 13).

This, however, is a casualty probably of rare occurrence, and altogether escaped in fine seasons; but there is another maggot which never fails to annoy the grower of this valuable vegetable. Disease is not required to engender these caterpillars, for the fuller and healthier the pods, the more likely are they to contain the insect we allude to. If our surprise has been naturally excited at the little that is known of the transformations of the Pea-weevils, how much more extraordinary is it that no author, that I am aware of, has even ventured to hint at the name of the parent of these disgusting maggots, which are amongst the oldest enemies to the crop, sparing neither field nor garden peas, and annually making their appearance. I have frequently tried to rear them, but with no success; the nearest approach was made by a friend, who found one had spun a silken web of the finest texture, between a piece of paper in a chip box, but the caterpillar then died.

Worm-eaten green peas are no doubt familiar to every housekeeper as well as to the cultivator, for who has not observed that when that excellent pulse is getting old or going off, numbers of the peas are infested by maggots in the pods? There is a cavity in the pea (fig. 14) which has been eaten by a caterpillar (fig. 15), who, if not present at the time, generally leaves ample evidence of the meal he has made (fig. *i*).

* Royal Agric. Jour., vol. iii. p. 69, pl. D, f. 31—33.

These larvæ vary somewhat in colour; those I examined in July, 1841, were fleshy and yellow, sparingly clothed with hairs; they had 6 pectoral black feet, 8 small abdominal and 2 anal ones scarcely visible; the head was black and shining, the first thoracic segment had a brown band with a spot of the same colour at the base of the leg; most of the following segments had 8 brown dots, each producing a fine hair (fig. 16, greatly magnified).

The cavities in the pods were filled with excrementitious pellets (fig. 14, *i*), and the peas were full ripe, indeed those in some pods were changing colour and hard. Only one maggot was found in each, and later in July others from the peas buried themselves the instant they were put upon some earth; the head and thoracic segment of these were brown, not black, and they were stouter than the earlier ones, it is therefore probable that they had changed their skins, and at the same time I observed one from another sample of a more slender form, which had the head and thorax intensely black. In August some peas, although not old, were very much eaten; a portion of the maggots had black, but most of them brown heads. I put these into a breeding-cage, and others into a garden-pot in which a pea was growing, and tied infested pods to the plant, but this plan failed also. During the present year I have not met with any peas thus affected, to repeat my experiments; but I hope it will not be long before this interesting inquiry is satisfactorily answered. There can be no doubt that the author of the mischief is a moth, which deposits its eggs about May, I expect, either in the flowers or upon the young pod. Some persons have supposed they were the offspring of the Weevils, and many more of a beetle called *Bruchus*, which infests ripe peas, and of which we shall have occasion to speak shortly.

Humble-bees.

It is a well-established fact that bees are exceedingly serviceable in rendering flowers prolific; but it is not so generally known that many are greatly injured by them, and few farmers are probably aware that Humble-bees in some seasons deprive them, it is believed, of a very large proportion of their crop of beans, by puncturing the base of the flowers and rendering the incipient pod entirely or partially abortive. Many garden flowers are similarly attacked by the bees, as larkspurs, azaleas, fuchsias, salvias, snap-dragons, &c. In all probability the peas in the fields do not escape, and in the neighbourhood of Manchester crops of scarlet-beans have been almost destroyed by them.* The cause of the Humble-bees thus damaging the crops of beans and flowers arises possibly from some unusually large females, for in-

* Mr. W. Charlton, in the Gardener's Chron., vol. i. p. 596.

dividuals of the same species vary greatly in size, not being able to creep into many flowers that are too small to admit of their bodies, and too long to allow of their reaching the nectary with their tongues: they are not, however, to be thus baulked of their feast, and instinct directs them to the exact spot on the calyx beneath which the nectar is stored (pl. R, fig. 17, *k*): there they nibble with their strong jaws (fig. 19, *l*) until they are enabled to introduce their proboscis (figs. 18 and 19) and obtain the desired treasure. It is surprising, too, that in flowers of a peculiar structure the bees make two holes, to extract the nectar on both sides of the germen, as noticed by Mr. C. Darwin,* who considers the holes are made simply to save trouble. The extent of their operations may be imagined by his statement, that in the Zoological Gardens, in August, 1841, "All the flowers of *Salvia Grahami* and the *Antirrhinum*, which I looked at in different parts of the garden, were bored; and out of the many hundreds in bloom in the two large beds of *Stachys* and *Penstemon*, I could not find one without its little orifice, nor did I see one bee crawl in at the mouth."

We must not farther indulge in these garden-walks, but return to the crops. On the 23rd of May, 1841, Mr. Gordon, who has the charge of one of the departments in the Horticultural Garden at Chiswick, called my attention to this subject. The broad-beans were full in flower, and he pointed out to me the blossoms which had been perforated by bees. The orifice (fig. 17, *k*) was invariably on the upper side of the calyx and near the centre, or a little more towards the base; the incision passed through the calyx, as well as the upper lobe of the flower, into the nectary containing the honey, which proved a great detriment to the crop, for the punctured flowers cannot perfect all the beans in the seed-vessel, or the pod proves altogether abortive; and out of clusters of from 5 to 8 flowers only one or two had escaped the injury. On a subsequent visit I found many pods with a rough brown wound near the base, or they were distorted and deficient of beans, having only two or three at a distance from the puncture.† In the same year the horse-beans were in some places attacked to a great extent, and I was amused in the middle of June at witnessing the investigations to which a female Humble-bee (*Bombus lucorum*) subjected the flowers, flying from one bean to another, at last alighting with its head over the calyx, just putting its nose to the artificial aperture, and bustling off in a moment to others. From this movement I am led to presume that the sound flowers it left unnibbled were too far advanced, or from some other cause

* Mr. W. Charlton, in the Gardener's Chron., vol. i. p. 550.

† Gardener's Chron., vol. i. p. 485.

contained no honey, and that the wounded ones continue to secrete the nectar after they have been tapped.

The Humble-bees form one of the finest groups of British bees, whether we consider their size or the rich contrast of colour they exhibit; and from the genus containing nearly 40 species,* each composed of males, females, and neuters, there is great variety amongst them, and their specific distinctions are often complicated. We need however only regard two species, which were detected in the act of robbing the Beans as we have stated, namely, *Bombus terrestris* and *B. lucorum*.

All Bees belong to an ORDER called HYMENOPTERA, forming the FAMILY APIDÆ and the GENUS BOMBUS; the first species was named by Linnæus.

3. B. terrestris, the Earth-bee (fig. 18). The *females* and workers, which are the most abundant, are only to be distinguished by their size, the former being much the larger, sometimes measuring an inch and three-quarters when the wings are expanded; they are densely clothed with the finest hairs of the deepest black, with 3 bright ochreous bands; the head is short, black, and punctured, the face is oval, the nose bare, with a broad notched labrum, beneath which are 2 strong mandibles which cross in repose, rounded, and more or less notched internally towards the apex (fig. 19, *l l*); below these is concealed the proboscis (fig. 19) composed of 2 strong horny pointed valves called the lobes of the maxillæ (fig. *m*), which have minute palpi at the base; between these is placed an elongated chin, which enables the bee to contract or lengthen the tongue (fig. *o*), which is long, linear, and rough at the apex, to absorb the honey; on either side is a very long palpus or feeler, attached to short joints called scapes; the next joint is very long, producing an elongated acute joint, to the apex of which is attached a slender portion, divided into two joints (fig. *n*); † the eyes are large, long, and vertical; 3 ocelli, or little eyes, form a transverse line on the crown; and below them at the middle of the face are inserted 2 antennæ, which are longer than the *head*, dull black, thread-shaped, and 12-jointed; the basal joint is the longest, and forms an angle with the remainder, the 2nd is minute, 3rd longer, the following short, the apex rounded and wedge-shaped: the thorax is sub-globose, with a broad ochreous band in front; scutel large, transverse, semi-ovate: abdomen very large, oval, convex, the 2nd segment and 2 or 3 of the apical ones deep ochreous: wings 4, tinged with yellowish brown, the nervures pitchy; superior ample, with a long marginal, 3 submarginal, and 3 large discoidal cells; inferior wings much smaller: legs 6, very strong, hinder the largest; shanks, anterior short, convex externally, as well as the intermediate, each with a spine at the apex, hinder compressed, very shining outside, greatly dilated, the edges ciliated, the interior angle with 2 spines; feet long and brown, basal joint very large,

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* Curtis's Guide, Genus 723.

† Ample dissections of the various organs will be found in Curtis's Brit. Ent., pl. 564.

compressed, greatly dilated, and glossy in the hinder, with a strong tooth outside at the base, 3 following joints small, 5th clavate, terminated by a pair of strong claws, furcate internally.—*Obs.* In old specimens the yellow bands are often brighter, and the tip of the body is quite white. The *male* is distinguished by having 13-jointed antennæ, and no tooth at the base of the 1st joint of the hinder feet; the face is shorter, and the nose clothed with a mixture of yellow and black hairs. It is considerably less than the female, but many of the working-bees or neuters are much smaller.

4. B. lucorum of *Linnæus*, the Wood-bee. It is similar in form to the foregoing species, and the males are the same size. They are black; the nose and crown of the head are clothed with bright yellow hairs; there is a band of the same on the fore part of the thorax and the base of the abdomen, including the scutellum; the apical segments are clothed with pure white hairs, having a black band across the middle of the body; the hairs on the under side are principally yellow; the feet, excepting the broad basal joint, are rust-coloured.

Humble-bees form their nests in old loose walls, amongst broken bricks and stones shot down as rubbish, in banks, at the roots of trees, &c. During the first fine days of spring, or even earlier, the females, which often pass the winter in mossy banks, come forth to collect honey and pollen from the catkins of the willow; later in the season the neuters become active, but the males are not abundant until the autumn. In the summer Humble-bees may be seen collecting moss for the purpose of covering their nests, which are sometimes lined with wax. The comb is irregular, and formed of brown oval cocoons made of a kind of silk daubed with wax, amounting sometimes to 60, being adapted in size to the three sexes. If, therefore, it be desirable to stop the mischief caused by these animals, the nests must be destroyed at the end of summer, and the females collected as they come out in the spring. Humble-bees, however, have many natural enemies amongst the feathered tribes, especially the Butcher-bird, *Lanius colluris,* which impales them on thorns; there is also a dipterous fly of great beauty, named *Volucella inanis*, which, hovering about woods from June to the end of August, deposits its eggs in the Humble-bees' nests, and the larvæ live upon the brood of the bees. The most formidable foe, however, is the caterpillar of a moth called *Ilythia colonella*,* which feeds upon the honey, and when full fed, spins a web of a close woolly texture, so tough that I could not rend it in pieces. The moth creeps into the nest in June to deposit her eggs, and the caterpillars live in families sometimes of 500, to the total destruction of the progeny of the poor Humble-bees. Probably

* Hubner's Samlung Europaischen Schmetterlinge Tineæ, pl. 4, f. 22 male, f. 23 female.

these checks are sufficient to keep this tribe of insects under without the intervention of man, and by pushing persecution too far, it is not improbable that "in avoiding Scylla we might fall on Charybdis," for if the Humble-bees could be extirpated, in all probability the beans would not be so prolific, and by the destruction of some flowers it is almost certain that those which escape form larger and finer pods and seeds. These are fit subjects for the cultivator to investigate, and into his hands we consign the subject. *Hive-bees* have been accused also of assisting in puncturing the flowers, but Mr. Darwin thinks they only participate in taking advantage of the labours of their bustling neighbours, as they do not exhibit the adroitness which the Humble-bees do in detecting the hidden treasure.

Aphides, or Plant-lice.

Another tribe of insects we have to record, which destroy or injure the Peas and Beans in the field, are the *Aphides*, from which no crop is entirely free; the former of these plants are often smothered with the "Lice," or "Green Dolphin," as they are termed, and the latter seldom escape from the attacks of another species: these, from their sooty colour, have received the appellation of Black-fly, Black Dolphin, or Collier. Like all the insects of this family, of which we have already described many, their appearance is very sudden, and their increase so prodigious, that crops suffer severely from their visits. In 1833 the Beans were almost totally destroyed by them in Yorkshire. In 1841 they were abundant in my garden near the Regent's Park; but in 1842 I never saw one on the spot, yet the Beans around Sandgate in the same year were very much injured by them. On the 5th of last June I could only find apterous specimens (fig. 20, and 21 highly magnified) on the broad-bean tops, but on the 11th I detected some winged specimens (fig. 22, the cross lines show the natural size), and the Beans in the potato rows were smothered with them, whilst those in a separate bed were free, and by topping them the crop escaped.

Dickson says, "In such summers as are dry, beans are frequently liable to be much injured by the attacks of the *Black-fly*, or what is often termed the *Dolphin*, the whole field in particular cases being in danger of being destroyed in the course of a few days. In order to prevent this mischief it is the practice in some places to cut off the tops by means of a scythe or other sharp implement, as it is mostly on the tops of the plants that the insect first appears. When this method is adopted it should be performed on the very first appearance of the fly, otherwise little benefit can be produced; as, perhaps, by removing the first insects that show themselves, their propagation may in some degree be

prevented."* I have little more to add than to confirm Mr. Dickson's sensible observations, and the excellence of the remedy he proposed, which is now practised by all good cultivators, I believe. Late in the year I have seen the Colliers on the under side of French and scarlet bean-leaves, and this mild autumn they were observed upon the latter plants during the last week in October. Where the eggs are laid by the *Aphides* remains a mystery. It cannot be upon the Beans; and as the apterous specimens are the precursors of the winged ones, as far as my observations have gone, they are not able to transport themselves in the first instance. Having once established themselves upon the bean-tops, their multiplication is no longer mysterious, for, being then viviparous, they breed at a rate which would be incredible, if it were not well attested.† As the Colliers are readily detected by their peculiar colour, often making the bean-stalks as black as soot, no one can find an excuse for neglecting to apply the remedy of removing the tops on the first indication of their presence. This, however, is not all that is required, for if they be not collected and burnt as the operator proceeds, the animals will soon crawl to the living plants, and those that have wings will fly away as the tops wither. Troublesome, if not expensive, as the method would be, I should recommend the employment of women and children to cut or pinch off the tops of the beans into skeps, heaping them up at one end or corner of the field and burning them as the work proceeds, or they might be thrown into a pit and trampled down with unslaked lime.

The *Aphides* exhaust the plants by sucking the sap, so that when they abound, it is in vain to calculate upon a good crop, if they be not speedily arrested. The Lady-birds and their black larvæ ‡ soon come to the aid of the farmer and destroy immense quantities, as well as the maggots of two-winged flies,§ and minute *Ichneumonidæ* puncture the apterous females, as they do other plant-lice,|| and where such agents are ascertained to be numerous, perhaps the reduction of the noxious animals may be safely intrusted to their instinct; but I may here again notice the utility, and even necessity, of agriculturists being acquainted, to a certain extent at least, with the species of insects inhabiting their fields, for Mr. Middleton ¶ acknowledges that he did not know whether the Lady-birds are the parents or the destroyers of the Black Aphides so injurious to the beans. This, however,

* Dickson's Practical Agric., vol. ii. p. 597.
† Vide Royal Agric. Jour., vol. iii. p. 51.
‡ Coccinella, ib., p. 57, pl. C, f. 13—16.
§ Scæva, ib., p. 65, pl. C, f. 23—25.
|| Aphidius, &c., ib., p. 58, pl. C, f. 17, 18.
¶ Agriculture of Middlesex, p. 192.

is many years since, and I trust that no one who discusses agricultural subjects in future will be thus compelled to confess his ignorance. It only remains now to describe the Colliers.

They belong to the ORDER HOMOPTERA, the FAMILY APHIDES, and the GENUS APHIS, and, from the species living upon the common bean called *Vicia Faba,* it has been named by Scopoli .

5. A. Fabæ. *Female* apterous, ovate, sooty black; antennæ shorter than the body, tawny, except at the extremity, setaceous, indistinctly 7-jointed, 2 basal joints minute, 3 following elongated, terminal one slender: rostrum bent under the breast in repose, rather long and stoutish: eyes prominent: abdomen with bluish white spots down each side of the segments; tubes short. Six legs stoutish, ochreous, shining; thighs more or less pitchy; shanks pubescent, pitchy at the apex, hinder the longest and curved; feet short, black, and biarticulate, terminated by minute claws (fig. 20, f. 21 the same magnified). *Obs.* In some examples the head is ochreous and the legs entirely of the same colour, whilst a few are of a rusty colour. *Males?* winged and black: head trigonate; eyes prominent; antennæ as long as the body, slender, setaceous, tawny at the base, distinctly 7-jointed, 2 basal joints very short, 3rd the longest, 6th much shorter than the 5th and 7th: thorax shining, deeply channelled, forming four convex lobes including the broad scutellum; the collar is very short, but forming lateral lobes: abdomen oval, not broader than the thorax; the tubes are longer and slenderer than in the apterous sex: 4 wings deflexed in repose, iridescent but slightly tinged with brown; superior very ample, thrice as long as the body, the nervures and stigma are pale brown, the apical cell ovate-conic, with a double furcate one below it; inferior wings small: legs pubescent, ochreous, rather long and slender, especially the hinder pair; thighs more or less pitchy, as well as the extremities of the tibiæ; the feet are black, short and slender, having a minute basal joint and 2 little claws at the apex (fig. 22, highly magnified).

BRUCHIDÆ.—The Pea and Bean Beetles.

Peas and beans are often inoculated in the field by a group of beetles, called improperly "Bugs" by the farmers; and this subjects them, like the cereal crops, to great injury and waste after they are stacked or housed. From their destructive nibbling propensities, these beetles have received the appellation of *Bruchus.* It is singular that they should be almost confined to leguminous or pod-bearing plants, infesting various kinds of pulse and many foreign seeds which are of great value to the inhabitants either for home consumption or as articles of commerce; amongst them are recorded acacias, mimosas, and some palm fruits.* A leguminous seed named Gram, and much used when boiled as food

* Latreille, Hist. Nat., vol. xi. p. 401.

for horses in the East Indies, is consumed by them.* In Carthagena the ravages of a species of *Bruchus* are serious upon the seeds of the Dividivi or Libidibi, the legumes of which are so valuable a substitute both for oak-bark and galls.† In a considerable sample of those seeds which I obtained, I scarcely found one that had not either contained a *Bruchus* or in which I did not find one dead.

Happily in England there are but few native species of this Genus, and of those only one or two commit any havoc on the crops. Before entering upon their history I must not forget to make the cultivator acquainted with one which has found its way from North America into the southern states of Europe, and has become naturalized in the warmer departments of France. It is to be hoped that our climate will not suit the economy of this pest, for I have frequently found the beetles in imported peas.‡ The first notice we have of this insect was from M. Kalm, a Swedish traveller, who stated § that in Pennsylvania, New Jersey, and the southern parts of New York, this beetle, or rather its maggots, were making such ravages amongst the peas, that the inhabitants had been obliged to abandon the culture of that excellent and useful pulse.

As the economy of this species has been well investigated, I shall relate what has been published regarding it. The beetles pair in summer, whilst the peas are in flower and producing pods; the females then deposit an egg in almost every pea which has just formed. From the outside of these peas, when arrived at maturity, they do not appear damaged, but on opening them one generally finds a very little larva, which, if left to repose, remains there all the winter and part of the following summer, consuming by degrees all the internal substance of the pea, so that in the spring the skin only remains, after which it is transformed into an insect with scaly wing-cases, which pierces a hole in the skin of the pea (fig. 33), from whence it comes forth (fig. *w*), and resorts to the fields sowed with that pulse, in order to deposit its eggs in the new pods.‖ I think it is Dr. Harris who says that "the eggs are laid only during the night or in cloudy weather; that each egg is always placed opposite to a pea; that the grubs, as soon as they are hatched, penetrate the pod and bury themselves in the pea; and the holes through which they pass are so fine as hardly to be perceived, and are soon closed."¶

* Kirby and Spence's Introd. to Ent., 6th ed., vol. i. p. 143.
† Trans. Ent. Soc., vol. i. p. xxiv.
‡ Those from Odessa are, I think, the worst.
§ Voyage en Amérique, vol. ii. p. 294.
‖ De Geer's Mémoires, vol. v. p. 280.
¶ Treatise on Insects.

Latreille asserts that if the summer has been hot, the beetles are disclosed the following autumn, and that the seeds will grow notwithstanding their inhabitants, which spare, owing to a wonderful instinct, the vital germ of the pea.

We can find nowhere any description of the egg. The larvæ have a soft whitish body, composed of many indistinct segments, and are apodes or only have some very minute feet. Their head is small, scaly, and armed with strong and sharp-cutting mandibles. They have 9 spiracles on each side for breathing. Before changing to pupæ the maggot eats a round hole from its cell to the rind of the pea, which in all probability it partially cuts through with its jaws, so that when the beetle shakes off the shroud which envelops it, by a slight dilatation of the body, the head is forced against this circular lid, which instantly gives way, and the new-born *Bruchus* comes forth as represented in fig. 33. In a great number of the peas the beetles will be found dead; but whether this arises from a lower temperature than they are accustomed to, not invigorating them sufficiently to leave their habitations, or whether they return to feed when they cannot make their escape readily, which may be the case when confined in sacks or heaped up in warehouses, I am not able to determine.

These beetles belong to the ORDER COLEOPTERA, the FAMILY BRUCHIDÆ, and the GENUS BRUCHUS. The species alluded to was named by Linnæus—

6. Bruchus Pisi, the Pea Bruchus. It is thickly punctured, black, densely clothed with short brightish brown hairs above, more grey and silky beneath: head rather small and drooping, ovate, with a distinct narrow neck; the nose narrowed and flattened, at the extremity of which is placed the mouth; this is composed of a crescent-shaped labrum, 2 trigonate fulvous mandibles, partially serrated internally; 2 jaws formed of 2 long hairy lobes, and producing 4-jointed black palpi; and of a broad bilobed chin, producing a large lip dilated before, from near the centre of which arise two triarticulate palpi: * the eyes are black, prominent, and lunate, having a deep notch below, where the antennæ are inserted; these are not longer than the thorax, clavate, and 11-jointed, the 4 basal joints are bright fulvous, the 1st is oblong, 2nd the smallest, ovate, 3rd and 4th obtrigonate, the following much larger, cup-shaped, terminal joint ovate: the thorax is twice as broad as the head, transverse, semi-orbicular, the anterior margin a little concave, the hinder bisinuated, the angles acute; the sides with a little notch at the middle, forming a minute tooth, and there is a slight transverse ridge across the middle; it is variegated with orange hairs, the lateral teeth white; there is a white spot before the scutel enclosed by a subquadrate black space; the scutel is minute and white: the wing-cases are considerably broader than the thorax, nearly

* These dissections are figured in Curtis's Brit. Ent., pl. 754.

flat, oblong, with ten fine striæ on each; there is a white dot on the 2nd interstice on each side of the suture towards the base, and a wavy transverse line of broken white dots beyond the middle, surrounded by black spots and patches, especially towards the apex, which bears 2 pale dots: wings ample and folded: abdomen extending beyond the elytra, convex, and sloped off, forming a large semi-ovate apical joint, clothed with greyish pubescence, bearing 2 black or brown spots at the base more or less concealed, and 2 black shining ones near the apex: under side silky and slate-coloured, a whitish spot at the hinder angles of the pleuræ, and a white lateral dot on each of the five following abdominal segments: legs clothed with silky grey pubescence; hinder pair very long, with the thighs stout, having a minute tooth beneath near the apex; the shanks bidentate at the apex: the other 4 legs are much shorter and slenderer, with the tibiæ and tarsi tawny; the feet are 4-jointed, the hinder long and black, the basal joint greatly elongated, 3rd joint bilobed, 4th clavate; claws small, hooked at the base. Length from 2 lines to 2½ (fig. 35; f. 34, the female, highly magnified).

The *Bruchus* which abounds in this country in our fields and gardens, if not originally a native species, is at any rate perfectly naturalized, and the importation of foreign peas and beans for seed is annually increasing the numbers. Some foreign long-pod beans which I purchased last spring were infested to a great extent. I picked out, as far as I was able, those which contained insects and planted the rest, yet I saw a few of the *Bruchi* running over the bean-flowers in the month of June. This species received from Linnæus the name of

7. Bruchus granarius, the Grain Bruchus. It is smaller than *B. Pisi*, being generally less than 2 lines in length (fig. 31); but is very similar in form. It is black and punctured, but less densely clothed with short brown hairs; the antennæ are not so much incrassated at the extremity, but the 4 basal joints are ferruginous: the thorax is not so broad, and more bell-shaped; the lateral tooth is very indistinct; and, besides the white hinder angles and the triangular spot before the scutel, there are 2 white dots on the disc: the wing-cases are sprinkled with whitish spots of hairs, the suture forms a brown stripe, whitish at the base; there are 4 white dots on the disc, separated by a black longitudinal line: the wings are ample: the exposed apical joint of the abdomen, called the pygidium, is densely clothed with greyish pubescence, in certain lights exhibiting 4 minute indistinct dark dots: the under side is similarly spotted: the legs differ in having the first pair only ferruginous, with the thighs of the same colour, excepting the base, and the hinder shanks have the internal spine elongated (fig. 32). *Obs.* Specimens of this insect are frequently so rubbed that they appear almost entirely black, from the hairs or pubescence being worn off.

This species, which is everywhere abundant as early as February on the furze when it is in bloom, inhabiting also the flowers of various other plants in the beetle state, as the rhubarb,

meadow-sweet (*Spiræa ulmaria*), &c.,* is a most destructive insect in our pea and bean fields, the larvæ feeding in the seeds and sometimes destroying more than half the crop. They are exceedingly abundant in some parts of Kent, where they often swarm at the end of May, and are occasionally found as late as August; indeed I have just killed one, imported with the Russian beans, which has been alive in a box since the end of September. It attempted to fly away in October; it then became torpid, but on warming it by a fire in the middle of November it was as lively and active as in the height of summer, and I dare say would have lived through the winter.

It is said that the female beetles select the finest peas to deposit their eggs in, and sometimes they infest crops to such an extent that they are eaten up by them, little more than the husk being left. The various kinds of beans are equally subject to their inroads; besides the long-pods I have alluded to, I have had broad Windsor beans sent to me containing these *Bruchi*, and Mr. C. Parsons transmitted me some horse-beans in the beginning of August, 1842, which were entirely destroyed by them. Mr. F. J. Graham showed me some seed-beans which were inoculated by these beetles to a great extent, and some of them were alive in the seeds; yet to any one ignorant of the economy of this pest, there would not appear the slightest external indication of their operations. I also received from a gentleman residing in Norfolk a sample of seed-beans from Russia for winter sowing, a large proportion of which was perforated by this *Bruchus*.

It has already been intimated that as the beetles generally leave the germ uninjured, the vitality of infested seeds is not destroyed. I doubt, however, if they produce strong healthy plants; and from my own experience I have no doubt, if peas or beans be sown containing the *Bruchus granarius*, that the beetles will hatch in the ground, and thus the cultivator will entail upon himself a succession of diseased pea and bean crops. Now to avoid this loss the seed should be examined before sowing, when to an experienced eye the presence of these beetles will be discernible, where to a common observer they would appear sound and good. It has been shown in the history of the foregoing species that the maggots, when arrived at their full size, gnaw a circular hole to the husk or skin of the seed, whether pea or bean, and even cut round the inner surface which covers the aperture, so that a slight pressure from within will force this lid off: these spots are of a different colour to the rest of the seed, generally having a less

* The larvæ are also recorded as inhabiting the lentils in France, also gesse, beans, and all sorts of vetches. Ency. Méthod., vol. v. p. 198.

opaque appearance and often are of a duller tint: on picking off this little lid, a cavity will be found beneath, containing either a maggot, pupa, or beetle. On splitting one of the horse-beans (fig. 30), I found a pupa in the cell (fig. *v*), but most of them were occupied by the perfect insects. At a more advanced period the beans tell their own story, by the holes which are visible from whence the beetles had escaped or are ready to do so, as in the Russian beans (fig. 28), where the tail of a beetle is visible at fig. *t*: on these beans were little dark dots, looking as if they had been made with a red-hot needle, which I have frequently observed in other samples; at this point the husk is generally indented and sometimes quite perforated. Whether these are caused by efforts of the larvæ to penetrate the seeds when first hatched from the egg, or from parasitic Ichneumons searching with their oviducts for a nidus for their ova, I cannot say. From the large horse-beans (fig. 29) most of the beetles had escaped, and their cells were occupied by other maggots, which will shortly deserve our attention.

There is another important but neglected question to which we have more than once alluded in these essays,* namely, the effect of extensively infested crops upon the constitution and health of those who feed upon them, whether animals or man. We learn from the authors of the 'Introduction to Entomology,'† that M. Amoreux, a French author, alludes to "an alarm that was spread in some parts of France, in 1780, that people had been poisoned by eating worm-eaten peas, and they were forbidden by authority to be exposed for sale in the market; but (it is added) the fears of the public were soon removed by the examination of some scientific men, who found the cause of the injury to be the insect of which I am now speaking (*Bruchus Pisi*)." Here is an admission of an injury done to the public by peas infested with the *Bruchus Pisi*; and in December, 1845, I received a communication from the Secretary of the Royal Polytechnic Institution, bearing directly upon this subject. Mr. Longbottom says, "I have been requested by the Bishop of Norwich to forward for your inspection the accompanying sample of beans lately brought from Sicily. They were purchased by a cabriolet proprietor for his horses, but finding that the health of the animals was much deranged from feeding on them, they were carefully examined, and almost all of them found to contain an insect."

This sample of broad-beans, amounting to 37, contained 16 that were infested by a *Bruchus*, some having only 1, others 2 and 3 in each, and about 6 or 7 of the beetles were alive at the time.

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* Royal Agric. Jour., vol. vii. p. 108.
† 6th ed., vol. i. p. 143.

I found also one full-grown maggot, and a parasitic fly in a cell lined with a shining membrane. The beans with few exceptions appeared sound outside; but on a more searching examination pale or horny spots were discoverable on the skin (fig. 24, *p*), or a little space marked merely by a delicate circular line indicated what might be expected beneath, as exhibited higher up in the same figure. There were occasionally pitchy dots or punctures, which possibly might be the spot where an egg had been deposited, for in some instances the incision entered the farinaceous substance of the bean, and in others a small maggot had been feeding in his little cell, but from the size and form of the head I do not think it was the larva of the *Bruchus:* rarely a larger hole was visible, which had been eaten by the beetle preparatory to its escaping from the cell, immediately on its bursting from its pupa shroud (fig. *q*). On cutting open the beans, some contained 2, 3, and even 4 cells (fig. 25); in a few were larvæ of various sizes (fig. *r*), in which case there was a good deal of farinaceous powder around them; others contained the beetle just changed, with the elytra not expanded; but in most of the cavities I found the perfect *Bruchus* (fig. *s*), with its head downward, and next the transparent spot, as shown in fig. 24, *p*, with the excrement and debris left by the maggot at the opposite end. Generally speaking, the portion where the germ of the seed is situated was left untouched, but occasionally the cell did extend to that part.

The maggots were like that already described—fleshy, wrinkled, with a minute, horny, ferruginous head, and their ochreous colour might be owing to their being dead (fig. 26, fig. 25, *r*, the natural size). The pupæ were, I believe, all dead, and presented various stages of development, some showing but faint traces of the future beetle, and others having every member perfectly formed (fig. 27). This beetle, which is a different species to any I have seen in the other samples, has been named by Schönherr*—

8. *Bruchus flavimanus.* It is similar in size to *B. Pisi*, but formed more like *B. granarius:* it is black; the head and thorax are clothed with short orange-coloured hairs, having a distinct cream-coloured triangular spot before the scutellum, which is of the same colour; there are two minute white dots on the disc; the lateral teeth are acute and pale: the wing-cases are of an ashy-white, with a few brown spots; the suture is ochreous-white, and there are four white dots on the disc: the exposed apical segment of the abdomen is ochreous-white, with two oval olive-brown spots near the apex: on the under side, which is silky slate-colour, is a pale line under the shoulder of the elytra, and a row of white abdominal dots, as in *B. granarius:* the anterior pair of legs and 4 basal joints of the antennæ are bright ferruginous, the apical joint of the former brown; the other legs are clothed with fine ochreous hairs,

* Genera et Species Curculionidum, vol. i. p. 59.

and the hinder are notched and spurred like those of *B. granarius.* Old specimens are black, and clothed with grey pubescence, the upper and under sides being often of the same colour.

From the number of the beetles in the beans, this species seems to be the most destructive of all; but from the comparatively cold temperature of England, I expect our climate will not suit it, and therefore nothing need be apprehended by our agriculturists from its operations; but in purchasing beans for seed or food, good judgment should be exercised, and this may easily be acquired if a person will attend to our suggestions.

Before entering upon the remedies recommended by authors, I may mention that, as usual, the parasitic flies are employed to a great extent in keeping down the multiplication of the *Bruchi.* I have already discovered three species which no doubt puncture the maggots in their cells, depositing the eggs in their bodies, which hatch and feed upon the larvæ of the *Bruchi.* They all belong to the ORDER HYMENOPTERA, the FAMILY ICHNEUMONIDES ADSCITI, or ALYSIIDÆ, and two of them to the GENUS SIGALPHUS, and appear to be identical with a species named by Nees ab Esenbeck *—

9. S. pallipes. The *female* is black, shining, and similar to *S. caudatus,*† figured in a former plate of this Journal, but it is larger, and the ovipositor is shorter: the head is somewhat globose; the antennæ are as long as the body, composed of 22 joints; basal joint the stoutest, but not longer than the 3rd or 4th; the terminal joints globose: abdomen short, oval, with 3 striated segments vanishing towards the apex, which is finely punctured; ovipositor as long as the abdomen, the central oviduct ochreous; nervures of wings and stigma like those of *S. caudatus:* legs stoutish, bright ochreous; apex of hinder tibiæ, and all the tarsi, brown: length 2 lines, including the ovipositor; expanse 3 lines.

This is an abundant insect in England in the summer months. A female was taken from a cell of *Bruchus granarius* in the Russian beans, and a female of the following species from one of the Sicilian beans. As I cannot find it described, I have given it the name of—

10. S. thoracicus. It is similar in size and form to *S. pallipes*, but the thorax is of a red colour: all the legs are bright ochreous, the feet tipped with fuscous: the head was broken off and lost.

The parasitic fly which I have frequently found with the *Bruchus granarius* is much smaller than the foregoing species: it belongs to Mr. Haliday's GENUS CHREMYLUS,‡ and is named by

* Hymenoptera Ichneumonibus affinia, vol. i. p. 270.
† Royal Agric. Jour., vol. v. p. 499, pl. L, f. 39 and 40.
‡ Ent. Mag., vol. iv. p. 50.

Nees ab Esenbeck *Hormius rubiginosus.** It is also serviceable in destroying wood-boring beetles which infest our houses.

11. C. rubiginosus. *Male* shining, dull chesnut colour; head large, black, subglobose, finely punctured; eyes not large, lateral, but placed rather forward; ocelli 3, forming a triangle on the crown: antennæ as long as the thorax, ochreous, slender, and 11-jointed in the male; 2 basal joints stout, 3rd and following oblong-ovate: thorax as broad as the head, elongate-obovate; metathorax rugose, the hinder angles tuberculated: abdomen not longer than the thorax, small, oval, depressed, more ochreous, fuscous at the apex, which is very smooth and shining, with 2 distinct segments, 2 carinæ or longitudinal ridges at the base: the 4 wings are of moderate size, tinted with ochreous-brown; the nervures are very indistinct, the stigma tawny; the legs are stoutish and pale ochreous; the feet taper, and are 5-jointed, terminated by minute lobes. It is scarcely $\frac{1}{2}$ a line long, and the wings expand about $\frac{3}{4}$ of a line. The *female* is four times as large, being 1 line long, and 2 lines in expanse: the head is moderately large, thickly punctured, and does not shine: the antennæ are 12-jointed: the thorax is broader than the head, sometimes black or partially of that colour in front; the metathorax has 2 ridges behind: the abdomen is very thickly punctured, especially on the disc and at the base; the carinæ are very sharp, and the second segment very large; ovipositor shorter than the abdomen: superior wings with a large elliptical fulvous stigma, nervures ochreous, with a very large marginal cell, 3 submarginal, and a discoidal one.

Useful as these checks are, it is not in our power to command their services: their destiny is to prevent the total destruction of the crops of peas and beans from the ravages of the *Bruchi*, and it is left for the ingenuity of man to devise means of preservation, which, when well directed and persevered in, will generally reward his labour. It has been already stated that in Kent these insects are most abundant; from this fact it may be inferred that chalky districts suit the economy of the *Bruchi* in some way, either by favouring their transformations, or in producing wild flowers that are attractive to the beetles.† It would be worth while ascertaining what is the period for sowing peas and beans in the infested districts, as by some opposite course it is possible the increase of the beetles might be checked. Late sowing I apprehend would be the most dangerous, as the insects would then be committed to the earth with the seed, when they would not suffer from too low a temperature, but would come forth strong, active, ready to pair, and pursue their economy unrestrained. In May and June, as the summer approaches, the beetles have generally hatched or died in the seeds, and consequently they are free from this objec-

* Hym. Ich. affinia, vol. i. p. 156.

† *Bruchus Cisti*, another British species, is exceedingly attached to chalky districts, from the *Cistus Helianthemum* abounding on such soils, in the flowers of which it lives.

tion; and thus arises the opinion that if peas be kept over the year they become entirely free from the pest. Cultivators very properly prefer employing seed from a distant locality to using their own, but in this way land may be infested with insects which prey upon the fruit of a plant, and owing to our climate not perfecting some seeds regularly, as well as to the abundant supply at a cheaper rate from the coasts of the Mediterranean, the gardener especially has to rely upon a foreign market, and, as we have just shown, seeds from southern climates being greatly and constantly infested by insects, we are annually introducing the plagues, perhaps, of Egypt into our fields and magazines.* It has been observed in a New York newspaper, that beans and peas imported from foreign parts are always worm-eaten, whereas those grown and used in the same country are free from worm. What can be the reason of this? says the commentator.† Perhaps I am near the truth in saying that it is because imported peas and beans for seed may always be traced to a southern source.

The direct remedies are evidently limited, and require a few experiments to be first made to obtain a habit of application, which experience would soon teach those who are actually interested in the cultivation of peas and beans. It is recommended in Hovey's Magazine of Agriculture, "Immediately after gathering the seeds to subject them to the action of boiling water for one minute: by this means the little larvæ are destroyed, which are at this time just below the integuments of the pea, without destroying the vitality of the seeds. If the peas remain in the boiling water four minutes, most of them will be killed, but not all; of about forty peas thus heated last year, three vegetated, and are now growing."‡ It is now more than half a century since the celebrated Olivier recommended this method in France; and I shall conclude this portion of my subject by translating his observations:—"As the waste which the *Bruchi* occasion is more particularly injurious to cultivation and the food of the people, we ought to be so much the more desirous of finding some suitable means of preventing it. One of the modes, without doubt the most efficacious, would be to plunge into boiling water the different seeds which they attack, as soon as the gathering them is completed. But it is indispensable that all should be subjected to this immersion, in order to kill all the larvæ which they contain, and entirely to destroy the propagation of a family so prejudicial. One could also apply to these legumes a heat of from 45°

* The bean (Vicia Faba) is a native of Egypt, and the Pea (Pisum sativum) of the south of Europe.

† Gardener's Mag., vol. iv. p. 448.

‡ Gardener's Chron. vol. i. p. 815.

to 50°* in a kiln or oven : this heat, without altering them, would be sufficient to kill the larvæ. One well knows that these two means ought not to be practised upon grain destined for reproduction. We shall obtain the same object if we take off, immediately after the gathering, the husks of those legumes which are intended for winter provisions, and if we leave the two cotyledons, or halves of the seed naked." † I would merely add that immersing the peas and beans in the commonest oil would, perhaps, destroy the insects without injuring the vitality of the seeds ; but this remains to be ascertained.

Tinea sarcitella, the Sack or white-shouldered Woollen-moth.

The economy of this little insect is somewhat like the Wolf or Grain-moth,‡ for the larvæ will indiscriminately feed upon vegetable and animal substances. They frequently assist in the destruction of peas and beans when housed, which were previously infested by the *Bruchi*, as we shall soon have an opportunity of showing by the communications of various parties. In April, 1842, I received a letter from Mr. C. Parsons, dated East Tilbury, Essex, saying, "In the enclosed box are some beans, which, from standing in the sacks a twelvemonth, are injured in the way you will see by beetles,§ of which you will find some by cutting into the beans ; and the sacks are so strongly cemented together by the larvæ I have enclosed, that some of them actually require the strength of two men to part them." These were the caterpillars of the *Tinea sarcitella* (fig. 37 ; and 38, the same magnified). In December of the same year I received a similar complaint from P. B., who observed, that "from the wetness of last season some beans were got into a store in damp condition, and bred moths. As soon as the men could be spared the beans were cleared off and their receptacles whitewashed, but I now find that amongst some piles of sacks of peas, these insects, in the grub state, have introduced themselves between the sacks in sticky rings. As this is to no small extent, and there is a considerable quantity of beans and peas about, I wish to know the most effectual and rapid method of destroying this pest, without causing any further damage, by communicating a bad smell, &c., to the grain and sacks." In August, 1845, I heard of a stack of sacks sticking together from the same cause, and in November of that year a gardener in Surrey found living maggots in one of his seed-drawers, in which he had left some dwarf-peas,

* Of Reaumur, or 133° to 144° of Fahr.

† Hist. Nat. des Ins., vol. iv. No. 79, p. 3.

‡ Royal Agric. Jour., vol. vii. p. 89.

§ Bruchus granarius, described in a previous page, *vide* pl. R, figs. 31 and 32.

which were more than he wanted to sow in April, and with them two moths, which were the *Tinea sarcitella*. He squeezed a maggot out of one of the many cases or galleries which were made at the bottom of the drawer and attached to the wood. The peas had been put there for seed in September, 1844. I was not a little surprised at the end of last September, on taking out of a tin canister some bundles of barley which had been infested by the *Chlorops*,* to find a dozen caterpillars of *Tinea sarcitella* and the moth (figs. 41 and 42, magnified). The roots were covered with dry earth, and the stalks and leaves were mouldy, but there was nothing for the larvæ to feed upon excepting the corn, unless they found the pupæ of the *Chlorops* anywhere. The earth amongst the roots was connected by their webs, and many of the caterpillars were full grown.

Tinea sarcitella has long been recorded as a most mischievous little moth in our dwelling-houses, where it is common the greater portion of the spring, summer, and autumn. I have frequently observed it on the trunks of fruit-trees in gardens as late as September, and in the house in October and November. Sparrows' nests are also a great harbour for them, as the caterpillars revel amongst the feathers, wool, and rubbish which form the lining, and in this way they are always on the premises, and are constantly entering our sleeping-rooms and other apartments, whenever the windows are left open after sunset.

The female deposits her eggs upon clothes, blankets, curtains, carpets, or any woollen articles on which the larvæ feed, living in cylindrical cases which they form of the materials on which they subsist, covered with their excrement, and in which they change to pupæ. The caterpillar is a lively wriggling animal, about half an inch long when full fed (fig. 37); it is soft and white with a yellowish tint, and sparingly clothed with fine longish hairs, sometimes having a slate-coloured stripe down the back, arising from the food; the head is horny, of a chesnut brown, and furnished with little strong jaws and minute horns; the first thoracic segment is likewise horny and similar in colour, but paler; it has also 6 pectoral, 8 abdominal, and 2 anal feet: fig. 38, magnified. The pupa is sometimes enclosed in a distinct tough cocoon (fig. 39), similar in texture to the cases; the pupa is brown and shining (fig. 40), the sheaths enclosing the wings being very long, and the horns and eyes are visible through the horny envelope.

The perfect insect belongs to the ORDER LEPIDOPTERA, the FAMILY TINEIDÆ, and the GENUS TINEA of Linnæus, which, from its great extent, has been divided by modern naturalists into

* Royal Agric. Jour., vol. v. p. 489, pl. L, f. 20—30.

various other groups, one of which I have called LAVERNA,* to which our little moth belongs.

12. L. sarcitella of *Linnæus* shines like silk, being covered with minute slippery scales of an ashy brown colour; the head and thorax are densely clothed with depressed white scales; the eyes and a line across the collar black; the palpi or feelers are long and slender, divaricating and curved upward, composed of three joints, of which the second is longest, stoutest, and clothed with scales; the third long, tapering, and pointed: between them is rolled up the spiral tongue: on each side of the crown are inserted the antennæ, which are as long as the body, like fine bristles and ciliated in the male; the abdomen is silvery ochreous-white, tufted at the apex in the male, conical in the female, and terminated by a retractile horny ovipositor: the wings lying flat upon the body when at rest; the superior twice as long as the body, narrow, lanceolate, pale ashy-brown, freckled with a darker colour, having a dark-brown patch at the base and another at the middle of the pinion margin; there are also 4 similar spots about the disc, more or less distinct; the hinder margin is fringed with long ochreous and brown hairs; the inferior wings are shorter, narrow, and lanceolate, of a satiny-grey tint, beautifully fringed all round, the fringe very long on the inner margin: the legs are tawny-white spotted with brown; the fore pair are short, the hinder pair long; the 4 posterior tibiæ spurred at the apex, the hinder pair very long and hairy, with a long pair of spurs at the middle; feet 5-jointed, terminated by minute claws and pulvilli. Fig. 41, the moth at rest; fig. 42, the same flying: natural size, $2\frac{1}{2}$ lines long, 8 in expanse. Fig. 36 shows a small portion of the webs torn off from the sacks, containing the maggots (fig. *x*), and chrysalides in their cells (fig. *y*).

From a box full of the peas, their webs, and refuse, I bred a parasitic insect belonging to the FAMILY ICHNEUMONIDES ADSCITI and the GENUS BRACON, which, no doubt, lives in its larva state upon the maggots of the moth or its pupæ. It appears to be a variety of Spinola's.†

13. B. variegator. The *female* is black and pubescent; the head is hemispherical, bright ochreous, hinder part black, as well as a spot on the crown encircling the 3 ocelli; eyes orbicular and brown; antennæ thread-shaped, not so long as the body, with 20 distinct joints, the basal one stoutest and a little elongated: thorax broader than the head, obovate; the shoulders, a square spot on the back, and the scutellum, yellow or bright ochreous: abdomen depressed, oval, rather dilated, being broader than the thorax, but scarcely longer, thickly and minutely punctured, 7-jointed, scooped out at the base, forming a semicircular ridge with an indistinct dorsal one; the sides ferruginous-ochre, especially at the base; the apical segment ochreous, as well as the belly; the ovipositor projects, and is only half as long as the body: 4 wings

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* Curtis's Brit. Ent., fol. and pl. 735.

† Ins. Liguriæ, vol. ii. p. 118, and Nees ab Esenbeck, Hym. Ichn. affinium, vol. i. p. 89.

ample and smoky; the nervures and an oval stigma pitchy; superior with a large marginal and 3 submarginal cells, the second oblong-lanceolate: legs reddish-ochreous, hinder shanks dusky at their tips; feet 5-jointed, blackish at their tips, the hinder entirely dark: length $1\frac{1}{3}$ line, ovipositor $\frac{1}{3}$; expanse $3\frac{1}{2}$ lines.

I found 2 females alive the beginning of November, and they differ little, except in the colour of the legs, from specimens I have taken of both sexes on Hampstead Heath, the end of August. The male resembles the female, with the exception of the ovipositor, and the antennæ are a little longer.

I expect the mischief done to the peas and beans, which were rendered useless and very offensive, by the webs and excrement of the caterpillars, was owing to the crops being housed in a damp state, which caused mouldiness or minute fungi to be generated, as fermentation proceeded, amongst the seeds upon which the larvæ fed; or when the cotyledons or kernels softened, they might become an acceptable sustenance for them, as we learn from a French writer * that the caterpillars of *Tinea sarcitella* will feed, amongst various things, upon the Boleti of the birch and other trees, as well as in the rotten wood, and I am well aware that they will live upon the moist parts of corks in wine-bottles in cellars. It is therefore very necessary to keep such stores as dry and well ventilated as possible, and the more damp a place is, the more essential it is to expose seeds, stowed there, to the air and light.

It would be found very beneficial to air in the sun or kiln-dry sacks to destroy the innumerable mites, insects, and vermin which often infest them; and if sacks were thus kept sweet and clean, and were only manufactured of hemp or vegetable thread, I am pretty confident they would never be attacked by the Tinea caterpillars. Seedsmen, farmers, and gardeners should likewise be most careful not to use old sacks that have been mended with worsted instead of thread, much less any in which wool is spun in the material, as I think I have seen in some of foreign manufacture.

These insects, like all others, may be destroyed by fumigating with sulphur, or by allowing turpentine poured into saucers, to evaporate in the infested magazines; but it might be attended with danger, and is of little use unless the atmospheric air is entirely excluded, by filling every chink in the doors and windows with tow. Where small quantities of seeds are required to be kept merely in bags or drawers, if they be well dusted with pepper, it will preserve them from the attacks of insects, or a few ounces of camphor will answer the same purpose.

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* Godart's Lepidop. de France.

Gryllotalpa vulgaris.—The Mole-cricket.

I cannot have a better opportunity than the present of introducing the history of an insect which has ever been so destructive to various crops, that it is a dreadful scourge to the gardener, one of whom, in an old work, said, "Happy are the places where this pest is unknown." * From its remarkable habits of life, extraordinary strength, and large size, its interesting history is as well known to naturalists as its depredations are to the cultivator.

This animal has received its English names, of Mole-cricket and Earth-crab, from its burrowing like a mole, and some species of West-Indian crabs; but it is formed more like a lobster, and, from its supposed jarring song at night, it is also called Eve-churr, Churr-worm, and Jarr-worm. Mole-crickets inhabit every quarter of the globe; in Germany and various parts of the Continent they abound in corn-fields and meadows, where they commit extensive ravages, and are dreaded in the market-garden, eating almost every plant that comes in their way. Although the north of Europe has been tolerably free from them, it appears they are gradually extending their northern bounds, and I am surprised that we have not more evidence of their spoliation in this country, for they are far from uncommon in many places, especially in damp situations, as round the margins of ponds and along the banks of streams. In the south of France, farmers and gardeners complain of the damage their crops of peas and beans sustain from the Mole-crickets. In Germany they have been known to destroy one-sixth, and even one-fourth, of a crop of young corn, by eating off the roots. In the Botanic Garden at Berlin their devastations are so extensive, that duplicates of the more tender and uncommon species of plants require to be kept in pots, and in the West Indies it is stated that a species of mole-cricket has for some years been destroying the pastures all over the Island of St. Vincent, and has now on many estates attacked the young plants and cane-stools.†

The Mole-cricket differs from the field and house crickets very considerably in its economy, for although it resides under ground, it burrows like a mole horizontally, for which its prodigiously strong fore-feet are well adapted, and their strength is well supported by the power of the body and other members; for it is asserted, on the authority of Röesel, that it is capable of propelling 6 lbs. weight on a smooth surface.‡ It remains concealed in its burrows during the day, where it can run equally

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* Introd. to Ent., vol. i. p. 159.

† Probably the Gryllotalpa didactyla: *vide* Trans. Ent. Soc., vol. ii. p. xi.

‡ Röesel's Insecten Belustigung, vol. ii.

well backward and forward, for which purpose it is provided with two filaments like antennæ at the apex of the abdomen, and when these insects desire to change their abode, they leave it in the evening, and either crawl or fly to another locality; they have the power of leaping also. In these nocturnal peregrinations they are supposed to be luminous, and it has been suggested that the mole-cricket is the notorious "will-o'-the-wisp," the *ignis fatuus* of bygone days.

This insect belongs to the ORDER ORTHOPTERA, the FAMILY ACHETIDÆ, and the GENUS GRYLLOTALPA, and Latreille has named the species

14. G. vulgaris. It is 2 inches long, without the tails, which are half an inch more, and the wings expand $2\frac{1}{2}$ inches.* It is velvety and of a rich brown colour, but more ochreous beneath: the head is conical, and can be drawn into the thorax at pleasure; it is furnished with 2 prominent eyes, between which are placed 2 little eyes called ocelli: the 2 horns are twice as long as the head, inserted in cavities before the eyes, slender and tapering like bristles, but composed of from 60 to 100 minute joints, the basal one the stoutest and oval: the mouth is large, comprising a large, somewhat orbicular, upper lip; 2 strong, horny, elongated mandibles, curved and acute, with 2 or 3 teeth on the inside; 2 elongated jaws, forming an acute horny lobe, with a smaller sharp one inside, and a long palpiform one outside; the feelers or palpi are long and porrected, composed of 5 joints, the 2 basal ones small, 3rd the stoutest, 4th and 5th as long, the latter clavate with a globose fleshy gland at the apex; an under lip, which is elongated and terminated by a heart-shaped fleshy lobe, from the base of which arise 2 stiff parallel lobes, and on each side a stout, rigid, and pilose one, all of the same length; the 2 feelers are stout, rigid, and 3-jointed, the basal joint subglobose; 2nd and 3rd long, the latter the stoutest, the apex oval and fleshy. Thorax twice as broad as the head, convex, oval, the anterior margin concave: wing-cases short, somewhat oval, like parchment, yellowish-white externally, brown internally, partially covering one another in repose, with numerous strong longitudinal oblique and transverse nervures, forming cells which are more irregular at the base in the male than in the female, and this is almost the only external sexual difference, for the female has no ovipositor. Wings 2, ample, membranous, triangular, folded longitudinally, lying upon the back when at rest, and extending beyond the abdomen; they are dirty white, with an iridescent lustre, rayed like a fan with ochreous nervures and numerous transverse white ones; the costa is brown, as well as a stripe below it: the abdomen is twice as long as the thorax, very thick, soft, and cylindrical, composed of 9 or 10 rings; on each side of the apex is a hairy filament like a rat's tail, as long as the antennæ, but stouter. Legs 6, very strong, especially the anterior, which are compressed and dilated; the hinder pair are formed for leaping: anterior thighs short and broad,

* Curtis's Brit. Ent., fol. and pl. 456, where a coloured figure of the female is given, with various dissections of the mouth and other parts.

with a sharp semi-ovate tooth inside at the base; hinder pair long and incrassated; shanks of fore-legs trigonate, palmated, the apex being cut into 4 very strong spreading teeth; posterior long and spiny outside and at the apex: feet triarticulate, anterior compressed and trigonate, attached to the outside of the tibia, basal joint large, and with the 2nd forming 2 horny acute teeth, 3rd small and ovate, terminated by 2 straight unequal claws; in the other feet the 1st and 3rd joints are elongated, and the 2nd is very short; the claws are curved and sharp.

In June, or at the commencement of summer, the female constructs in the vicinity of her burrows a nest half a foot deep in the earth; it is 2 inches long and 1 deep, formed like an oval bottle, with a curved neck which communicates with the surface, and the inside surface is smoothed for the reception of the eggs, which amount to 300 or 400, and after they are deposited the female accurately closes the entrance. These eggs are about the size of turnip-seeds, but oval, shining, and brownish-yellow. The young hatch in July and August, or about a month after the eggs are laid: they immediately begin to feed upon the tender roots of the surrounding plants, whether corn, grass, or vegetables, and when these fail, then they go further in search of food; but subsequently to their first moult, which takes place a month after they emerge from the egg, the family disperses.

When the mole-crickets first hatch, they look very much like black ants, and are not more than one-eighth of an inch long; at this period they have no wings, they go on growing and moulting until they are $1\frac{1}{2}$ inch long, when rudiments of the wing-cases appear, and in this pupa state they remain feeding and increasing in bulk until the fifth or last skin is cast off, and the perfect-winged insect is developed and fit to propagate the species. This metamorphosis takes place at the close of spring; they live through the summer, pairing and laying eggs, and pass the winter in the earth, burying themselves deeper as the cold and frost affect them; there protected, they remain from October or November until the warm days of March again invite them to the surface, when they may be traced by the heaps of earth they throw up like little mole-hills; at other periods their presence may be detected by their operations, for yellow withered patches deface the pastures, and similar decay is indicated amongst the garden vegetables. Great doubts have been entertained as to their chirping, but Latreille states that after sunset they make a noise strong and shrill enough, which is said to be caused by the friction of the nervures of one wing-case over the other, and we learn from Mr. R. H. Lewis that the Mole-cricket is a very noisy insect in Van Diemen's Land. This song or call, like that of the crickets, is produced by the males to invite the females from their burrows, to prepare for the peopling of new colonies.

So great a pest are these insects, that there is no want of remedies or modes of extirpating them, which I will now proceed to discuss, and as they have been suggested and tried by first-rate cultivators, they cannot fail to be serviceable to those who may be so unfortunate as to suffer from the inroads of the Mole-cricket. I must, however, not omit to observe that some naturalists have an idea that this animal is even beneficial, from its carnivorous habits, but it is scarcely possible that so many experienced gardeners should have unhesitatingly stigmatised this insect in various countries for at least a century, if it did not deserve the bad character it has obtained. What will those, who maintain an opinion that Mole-crickets are beneficial, say to Mr. Brackenridge's unqualified statement? that "it is the greatest enemy the gardener has to contend with at Berlin, where it appears about the beginning of summer in myriads: nothing in the herbaceous way is proof against its ravages;" and he adds, "I have seen the stem of a dahlia an inch thick cut through by it in the course of a night, with as much precision as if done with a knife."* It is true that Dr. Kidd, in his admirable Memoir upon this subject, says that Mole-crickets prefer raw meat, and will attack each other; when the victor devours the flesh of the vanquished, but that they can live nine or ten months without food.† Bouché gives similar evidence of their ferocious disposition when he states that "luckily the mother devours a great number of her offspring, so that out of a hundred not more than eight or ten survive."‡ I can also bear testimony to their carnivorous habits, for one that I kept alive with grass turves in the cage, fed upon the caterpillars of the Lackey-moth,§ with which I supplied it for some time, and it is reported to devour worms and subterranean larvæ: this, however, only shows that the Mole-cricket is omnivorous.

It has been stated that Mole-crickets may be enticed under a glass or pot, by using some odoriferous composition, in the same way as rats are taken; and Scopoli, an Austrian naturalist, maintains that they are attracted by horse-dung and driven away by that of pigs, the warmth arising from the former probably suiting their economy. Mr. A. M'Barnet found that lamp-oil destroys them very readily, and soap-suds also will kill them, but not so speedily. He is of opinion that the refuse of soap-manufactories or any greasy manure might be serviceable, and also soot, lime, and like substances.‖ A simple plan of pouring water into their

* Gardener's Mag., vol. xii. p. 300.
† *Vide* Philosophical Transactions.
‡ Bouché, Naturgeschichte der Garten Insecten, p. 35.
§ *Clisiocampa neustria*, Curtis's Brit. Ent., fol. 229, and Gardener's Chron., vol. iii. p. 244.
‖ Trans. Ent. Soc. vol. ii. p. xi.

burrows first, and then a few drops of oil, which killed the insects by stopping their respiration probably, was actually purchased by Louis XV. By burying small garden-pots, into which about 30 drops of oil of turpentine must be previously poured, and covering them over with boards to keep out the earth, the Mole-crickets may be driven from their quarters, and the vapour will kill those that are near it, for their scent is so acute that it is said if a dead crab be introduced into their burrows, the effluvia will destroy them. M. Robert, of Toulon, places fresh turves on the borders where traces of the Mole-crickets are observed; they are watered every night, and the insects secrete themselves beneath, and are easily caught in the morning.* By persisting in this method, especially in April, May, and June, an infested place will soon be freed from them; this seems to be a good and available plan, especially in dry seasons, for Mr. Brackenridge says, "From the circumstance of these insects seldom appearing on the surface, and the rapidity with which they breed, no method has been fallen upon whereby they are likely to be eradicated, although hundreds of thousands are caught yearly by means of flower-pots plunged with their brims about two inches below the level of the surface, into which the insects fall during their nightly rambles." † In June and July the eggs may be destroyed in hundreds, by digging up the nest of the Mole-cricket, which an experienced gardener discovers with little trouble by tracing their winding burrows; or boiling water poured over affected parts in meadows will kill them, and urine or salt and water might be used advantageously.

However useful these suggestions may be, especially to the gardener, the following plan, recommended by Kollar, is the one to be adopted by the farmer on a larger scale. When there is a flat area of 500 or 600 yards, dig three or four pits in September, 2 or 3 feet deep and a foot wide; then fill them with horse-dung and cover them over with the earth: attracted by the warmth, all the Mole-crickets will resort to these pits from the surrounding neighbourhood on the first frost, and may then be easily destroyed.‡

Secure in their subterranean habitations from insect parasites to reduce their numbers, what a singular provision is made to keep the Mole-crickets in check, namely, the destruction of the young by their parent, to the amount of 90 per cent. and upwards, otherwise they would, first, cause such destruction to the various

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* Annales de la Soc. Hor. de Paris.

† Mr. Brackenridge's observations were published some years before M. Robert's plan was promulgated.

‡ Kollar's Naturgeschichte der schädlichen Insecten, p. 154, and Loudon's Translation, p. 147.

crops that famine must ensue, and next, the species would become extinct, for want of food for the young broods. The services also of the poor persecuted Mole are most essential in acting upon the masses of the insect race, and especially upon the formidable hordes of the insect which partakes of its habits, and from which it receives its name. Bouché says, "This little quadruped, called by Linnæus *Talpa europæa,* is continually digging in pursuit of insect larvæ, particularly grubs, mole-crickets, and earth-worms, and destroys them. I have observed (he says) that a field which contained an endless number of root-worms or mole-crickets was freed entirely by the moles in two years. They certainly destroy many young plants by burrowing, but their usefulness is found to overbalance by far the mischief they occasion, which is only when the plants are young. They likewise retire from those places where they find no prey to be caught, when they have freed the field from vermin. It is therefore not wise entirely to destroy the moles. At any rate, their numbers may be lessened in flower-gardens and meadows; yet even there they ought not to be extirpated, for the mole, with regard to the destruction of insects, may be regarded under ground in the same capacity as the sparrow is above ground.* Hoopoes, crows, and choughs eat many more."

Summary of the foregoing Report.

Pea crops subject to *mildew.*

The *early* ones destroyed by *millipedes* in cold and wet seasons.

Weevils named *Curculio lineatus* eat off the crops and notch the leaves, and likewise *broad-beans.*

They first *appear* in *March,* and are most destructive in *April.*

In the year 1844 they were universally distributed, and *ate* off the *second and third sowing.*

Feeding in March from nine or ten in the *morning* for the rest of the day, and *hiding* under clods at *night.*

They stand *feeding* on the edges of the *leaves,* and *fall down* as if dead when *approached.*

Marrowfat and *early peas* suffer *most, hog-peas* the *least,* from their attacks.

These *weevils* attack the *peas* first, then the *beans,* and lastly the *clover* and lucern.

Entire fields of *lucern destroyed* by them after *sowing two* and *three times.*

A field of *lucern* sown in *July* escaped their ravages.

In *September,* 1841, they *ate off* more than half an acre of *clover,* at the headland of a barley lay, and continued their operations in *October.*

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* Naturges. der Garten Ins., p. 165.

Where the *eggs* are *laid,* or on what the *larvæ* of the Weevils *feed,* is *not known.*

The *beetles* inhabit the *broom* and *furze flowers* early in the spring.

Do the *galls* on the *roots of beans* contain the maggots of these weevils?

Another weevil, called *Curculio crinita,* attacks *pea-crops* in the same way.

Three hundred feet at Brecon, more or less, *destroyed* by this species, as well as a *crop* in *Norfolk.*

Certain seasons favour, others *check,* their *multiplication.*

Destroying crops where peas had *never failed* for seven years.

Shaking the peas over *tarred* or *painted* strips of *canvas* a good *remedy* in the garden.

Although *soot, wood-ashes,* and *lime,* will not destroy the Weevils, they render the *leaves unpalatable,* when dusted over them.

Leaving *a row* of peas *undusted,* will prove *a good decoy,* when they may be destroyed by hot water.

Harrowing and hoeing recommended for field-crops whilst the dew is upon the plants.

Little *maggots* of a fly called *Phytomyza nigricornis* mining in the *pea-leaves.*

In wet seasons minute *maggots* live *inside* of *diseased pods.*

Peas when matured *worm-eaten* by the *caterpillar* of a *moth,* but the species has not been ascertained.

These *larvæ buried themselves* in July and August, and one spun a fine web.

Are not the *eggs laid* upon the *blossoms* or *young pods* in the spring?

Humble-bees render *beans abortive* by drilling a hole at the base of the flower into the embryo pod.

Scarlet beans and various *flowers destroyed by them* in the same way, the latter to such an extent that not a single flower in some beds could be found that was not punctured.

Whether the *bees* resort to this mode of getting at the honey to *save trouble,* or from the *flowers being too small* to admit of their entrance, is doubtful.

Beans spotted, *distorted* and *unprolific,* from the punctured flowers.

Two species of *Humble-bees* detected in the act, namely, *Bombus terrestris* and *B. lucorum.*

They form their *nests* in *old loose walls,* at roots of trees, &c.; *live through the winter,* and resort to the *willows* when in flower.

Butcher-birds destroy *Humble-bees* and the *maggots* of a fly called *Volucella inanis,* as well as the *caterpillars* of a moth named

Ilythia colonella, live upon the larvæ of the bees and consume their honey.

Peas smothered with *Aphides,* called lice or *Green dolphin.*

Beans infested with *Aphides,* known as the *Black dolphin* or Collier.

In 1833 the *bean crops* were nearly *destroyed* by them in Yorkshire.

The *first week* in June they were all *apterous,* in the *second week winged* specimens appeared.

Beans should be *topped* on their first appearance, and the *tops* collected and *burnt.*

The *Black dolphin* also infests *scarlet* and *French beans* as late as *October.*

They *exhaust* the plants by imbibing the *sap.*

The larvæ of *lady-birds,* the maggots of *flies,* and of minute *Ichneumons,* destroy the *plant-lice.*

Peas and *beans* attacked by beetles called *Bruchus,* and bugs by the farmers.

These *beetles* are nearly confined to the seeds of leguminous or *pod-bearing plants.*

Bruchus pisi, a native of *North America,* introduced into the *South of Europe,* and frequently found in imported peas.

Owing to the *ravages* of this insect in the *United States,* the *culture* of this crop was altogether *abandoned.*

The female deposits an *egg* in almost *every pea* when the plants are in *bloom.*

The *maggot* feeds in the *pea* during the *winter* and part of the *summer.*

The *beetles* are *hatched* in the *spring,* sometimes in the *autumn,* when they force their way out of the cell through the skin of the pea, which had been previously cut by the maggot.

They are often found *dead* in the *peas* and *beans.*

Bruchus granarius is the species *infesting* our *own crops,* and *imported* with seed *annually.*

It appeared on some *beans* grown from inoculated *foreign seed.*

It is abundant on the *furze* when in *flower,* and many other plants.

The *maggots* sometimes *destroy* more than *half the crop* in parts of *Kent.*

They *swarm* in *May,* and are found in *August* and probably later, for one imported with Russian beans was *alive* in *November.*

Peas and every variety of garden and field *beans* are subject to their *attacks.*

Infested *beans* often exhibit *no external signs* of the presence of the *Bruchus* to the *uninitiated.*

The *maggots* do *not* generally *destroy* the *germ*, so that the *seeds* will *vegetate*.

By *sowing inoculated seed* the *insects* are introduced and *propagated*.

Seed should be *examined before sowing*, and the *infested beans* may be detected by *dull circular spots* on the skins where no holes are to be found.

Minute *brown dots* on the beans, made by the *young larvæ* or by parasitic *Ichneumons*.

People poisoned in France by eating *worm-eaten peas* containing the maggots and beetles of *Bruchus pisi*.

Sicilian beans, containing the *Bruchus flavimanus*, affecting the *health of horses* which fed upon them.

Some *beans contained two and three beetles*, which were *alive* in *December*.

They *appeared sound*, being nearly free from holes in the skin.

Three species of *parasitic flies* have been discovered, whose *larvæ feed* upon those of the *Bruchi*, namely, *Sigalphus pallipes*, *S. thoracicus*, and *Chremylus rubiginosus*.

Chalky districts seem to be *favourable* to the increase of the *Bruchus granarius*, from the soil probably producing wild flowers which supply the beetles with food.

Late sown peas and *beans* most likely to *suffer* from the *Bruchi*.

Peas, if *kept over* the *year*, are *free* from this pest, from the *beetles* having *deserted* them.

Many of these *insect plagues* introduced with *foreign seed*, owing to their being grown in warmer countries, where *noxious species* are *more abundant* than with us.

To *destroy* the *maggots* in the *peas* without injuring their vitality, *immerse* the *seeds* in *boiling water* for *one minute*.

An immersion of *four minutes* in boiling water *will kill* nearly all the *peas*.

Kiln-drying at a heat of from 133° to 144° will *kill* the *insects* without altering the quality of the pulse, but such seed will no longer vegetate.

To *split the peas* and deprive them of the husks will *preserve* the *winter stores* from further injury of the *Bruchi*.

Immersion in *oil* would probably *kill* the *insects*.

Maggots of a little moth called *Tinea sarcitella* infesting *worm-eaten peas*, and *matting* the *sacks* together.

This is especially the case when *peas* and *beans* are *stored* in a *damp* condition.

These *moths* will *breed* in *drawers* where seed is put away for use.

They were *breeding* freely amongst the *dead roots* of some *barley* in a box.

They inhabit our *houses* and *gardens*, injuring all *woollen goods*.

The *eggs* are laid in preference upon *clothes, blankets, carpets,* &c. upon which the active wriggling *larvæ feed,* forming cases of the eaten materials, in which they undergo their transformations.

The *maggots* of a parasitic fly, called *Bracon variegator,* live upon the *larvæ* of the *Tinea.*

It is essential to *ventilate pea and bean stores,* to keep them dry and secure from these insects.

Empty sacks should be well *exposed* to the *sun* or *kiln-dried,* as opportunities offer.

Sacks should be entirely made of *hemp* or vegetable fibre, and never *mended* with worsted or patched with *woollen.*

Fumigating with *sulphur* or evaporating spirits of *turpentine* will *destroy* these *insects.*

Dusting the seeds with *pepper,* or enclosing *camphor* with them, will *banish* the insects.

The *Mole-crickets* a dreadful scourge in *corn-fields, meadows,* and *gardens.*

They are at present most *destructive* in *Germany* and the *South of France,* but are gradually *extending* their *northern bounds.*

In many parts of *England* they *abound.*

In Germany one-sixth and even one-fourth of *young corn-crops* fall a sacrifice to the *Mole-cricket;* they also attack *peas* and *beans.*

Most destructive in the *botanic garden* at *Berlin,* and destroying the *sugar-cane* in the *West Indies.*

It *burrows* under ground, living like a *mole* in miniature, and only comes forth in the evening and at night.

Mole-crickets have been supposed to emit the dancing light called the "*Will-o'-the-wisp.*" They *sing* or chirp in the *evening.*

The *female* constructs an *oval cell* in the earth in summer, to deposit her *eggs* in, amounting to 300 or 400.

The *young* hatch in about a month, look like *black ants,* live in *society,* feeding upon the roots at hand, until they cast off their first skin, when they *disperse.*

When *young* they have *no wings,* but attain *rudiments* of them as they increase in size, and after the 5th moult they are furnished with *ample wings.*

They pass the *winter* in the *earth,* and come forth in the *spring,* when they may be traced by their little *hillocks.*

Where they live the *grass* and *vegetables* become yellow, and *wither.*

They are *omnivorous,* feeding upon *animal* as well as *vegetable* substances, yet they can live 9 or 10 months *without food.*

They *fight,* and devour each other, and the *female eats* 9-10ths of her *offspring.*

They may be *enticed* into *traps* by certain *odours.*

Horse-dung is said to *attract,* and *pigs'-dung* to *drive them away.*

Oil and *soap-suds* will *kill* them. *Greasy manures,* soot, and lime, would assist in *banishing* them.

Water poured into their burrows with a few drops of *oil* will *destroy them.*

Garden-pots buried in their runs, with 30 drops of *oil of turpentine* in each, and covered over with boards, are *excellent traps.*

Fresh turves watered every night will *decoy* them to retreat under them.

Hundreds of thousands are *caught* at Berlin annually, by sinking *flower-pots* 2 inches below the surface.

In June and July the *eggs* are easily *destroyed* by *digging* up the *nests.*

Boiling water, urine, and *salt and water,* may be poured over *infested spots.*

Farmers are recommended to *dig pits* in September, 2 or 3 feet deep and a foot wide, *fill* them with *horse-dung,* and cover over with earth ; on the first appearance of *frost* all the mole-crickets in the field will *resort* to these *traps.*

Their *increase* would be so *prodigious* were it not for the extraordinary *habits* of the *females,* that *famine* must ensue where they took up their abode.

Moles most serviceable in hunting and *destroying* them : it is *unwise* to *extirpate* that little quadruped.

Crows and various strong-billed birds *devour* large numbers.

EXPLANATION OF PLATE Q.

Fig. 1. *Curculio* or *Sitona lineata* walking.
Fig. 2.* The same magnified.
Fig. 3.* The head in profile.
a. The antenna or horn.
Fig. 4.* Organs of the mouth.
b. The mandible.
c. The maxilla or jaw, and palpus or feeler.
d. The under lip and labial palpi.
Fig. 5.* The fore-leg.
Fig. 6. A pea-plant notched and perforated by the *Curculio* or Weevils.
Fig. 7. Another pea-plant entirely defoliated by them.
Fig. 8. A bean-leaf notched by the same *Curculio.*
Fig. 9. *Curculio* or *Sitona crinita* walking.
Fig. 10.* The same species magnified.
Fig. 11. The extremity of a pea-plant.
e and *f.* Pupæ of mining larvæ of *Phytomyza nigricornis.*
Fig. 12. A diseased pea-pod opened.
g. The shrivelled pea.
h. Maggots of a minute fly.
Fig. 13.* The same magnified.
Fig. 14. A worm-eaten pea.
Fig. 15. The caterpillar of a moth.
i. The excrement.
Fig. 16.* The caterpillar magnified.

Q

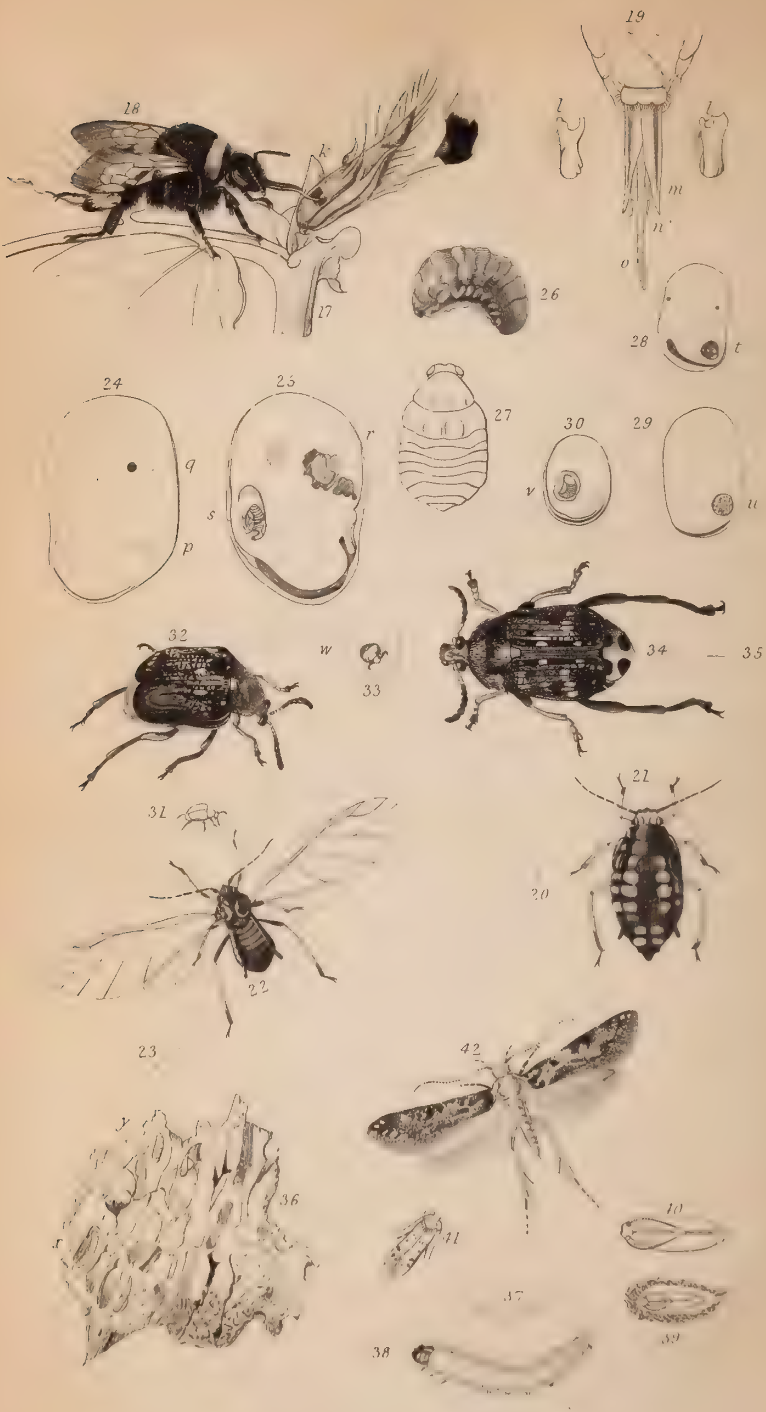
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PLATE R.

Fig. 17. Part of a broad-bean plant in flower.
Fig. 18. A humble-bee named *Bombus terrestris.*
k. The cavity bitten by the humble-bee.
Fig. 19.* The proboscis or mouth of the humble-bee.
l l. The mandibles.
m. The maxillæ.
n. The labial palpi.
o. The tongue.
Fig. 20. The bean-louse, black dolphin, or collier, *Aphis Fabæ.*
Fig. 21.* The same magnified.
Fig. 22.* A winged male ditto.
Fig. 23. The natural size.
Fig. 24. Outside of a Sicilian bean infested with *Bruchus flavimanus.*
p. A spot beneath which lies the pupa or beetle.
q. A hole eaten by the enclosed beetle.
Fig. 25. The same bean split, showing the inside.
r. The maggot of the *Bruchus* in the cell.
s. A pupa in the cell.
Fig. 26.* The maggot taken out and magnified.
Fig. 27.* The pupa magnified.
Fig. 28. A Russian bean infested by *Bruchus granarius.*
t. The tail of the beetle in its cell.
Fig. 29. A horse-bean first eaten by *Bruchus granarius*, and afterwards by the maggots of a little moth, as shown at *u.*
Fig. 30. A smaller bean containing *Bruchus granarius.*
v. The pupa in a cell.
Fig. 31. *Bruchus granarius* walking, in outline.
Fig. 32.* The same magnified.
Fig. 33. A pea infested by *Bruchus Pisi.*
w. The head of the beetle thrust out.
Fig. 34.* *Bruchus Pisi* magnified.
Fig. 35. The natural length.
Fig. 36. Portion of a sack matted together by *Tinea sarcitella.*
x. The maggots in their cells.
y. The pupæ, ditto.
Fig. 37. Outline of the caterpillar, full grown.
Fig. 38.* The same magnified.
Fig. 39. Cell or cocoon containing the chrysalis.
Fig. 40.* The chrysalis or pupa magnified.
Fig. 41. *Tinea sarcitella* at rest.
Fig. 42.* The same moth flying and magnified.

Obs.—Those numbers with a * attached refer to the objects which are represented larger than life. All the figures are drawn from nature.

Hayes, near Uxbridge, Nov., 1846.

Errata in the last Report, Vol. VII.

Page 81, line 9 from the bottom, *for* 'merdigera' *read* 'melanopa.'
101, line 4 „ *for* 'made' *read* 'expended.'

XXVIII.—*On the Geology of Norfolk as illustrating the Laws of the Distribution of Soils.* By Joshua Trimmer, F.G.S.

It is impossible to enter on an inquiry in which geology is connected with agriculture, without being reminded that we are indebted to the son of an Oxfordshire yeoman for those discoveries which laid the foundation of all our geological knowledge. It was William Smith who ascertained for the English strata down to the coal measures, that they have a regular and invariable order of succession and a general dip towards the east; so that in traversing the island from east to west, we cross the edges of beds which emerge successively from beneath each other, and form bands of various sandstones, clays, and limestones, ranging from S.W. to N.E. He also ascertained the important fact that each group of strata is characterised by a peculiar group of organic remains, by which it may be identified under doubtful circumstances: as, when the rocks above it and below it are concealed, or when the ordinary mineral characters have changed. He was also the first to point out the distinction between those regular strata, each of which must have been, in succession and for ages, the bed of the sea, inhabited by animals whose remains are deposited on the spots where they lived, and that loose covering of sand, gravel, and clay, often containing large boulders derived from far distant rocks, which is so generally distributed over the surface, and which, long called diluvium, is now regarded by a large and increasing number of geologists as having originated in the action of ice, partly terrestrial, but chiefly marine. These discoveries he prosecuted, under great difficulties, with the sturdy, indomitable spirit of an English yeoman. He completed his great work, the map of the strata of England and Wales, alone, almost unknown, through a great part of his career, with little assistance from private patronage, and no public support. To accomplish it, he exhausted his slender patrimony and the profits of a successful professional career. He paid that penalty, as Professor Sedgwick has said, which many men of genius have paid before him: he suffered, in his peace and in his fortune, from having outstripped the men of his own time in the progress of discovery. It was from foreign philosophers that he received the first acknowledgment of his merits. At home, to compensate for the long neglect which he had experienced there, honours were lavished upon him in his old age; geologists acknowledged him, with one consent, as the father of English geology; the Geological Society of London awarded to him the first medal, struck from the proceeds of a fund bequeathed to them by Dr. Wollaston for the encouragement of original discoveries; the University of Dublin conferred on him the honorary degree of

Doctor of Laws; and to solace the poverty to which he reduced himself, by the individual performance of that which ought to have been a national work, the Government conferred on him, at the request of the British Association for the Advancement of Science, an annual pension of one hundred pounds.

The phenomena of the stratified rocks, and of their organic contents, have attracted a large share of the attention of naturalists and philosophers, for the wonderful views which they disclose of the ancient natural history of the earth, the revolutions through which it has passed, and the various races of plants and animals by which it has successively been peopled. It was for their practical utility that his discoveries were chiefly valued by Smith: and, as an engineer engaged in planning and executing canals, draining land, laying out water-meadows, and superintending mining operations, he derived no small assistance from his acquaintance with the structure of the earth and the laws of stratification. His knowledge of the alternation of porous with retentive strata, and of the phenomena of springs dependent on this structure, enabled him to select the best lines for his canals, so as to economise the supply of water and to save expense in the construction of them; it caused him to be consulted on the means of overcoming difficulties by which the first engineers of the day had been baffled, simply because they were ignorant of those despised facts which he had so successfully observed and generalised; it enabled him to drain the Prisley bog, in which Elkington had failed, though he had received from Parliament a reward of one thousand pounds for the discovery of a mode of draining adapted to certain descriptions of wet soil, but not of general application; it enabled him to restore the supply of water to the hot wells at Bath, when it had escaped into a new channel; and to economise at Scarborough the scanty resources which the locality afforded of water fit for domestic purposes, so as to secure an adequate supply to its increasing population.

His habits of observing the action of the sea upon the coast taught him, by copying nature, to devise a simple, cheap, and efficacious method of stopping the breaches, more than a mile in length, in the sand hills, constituting the only barrier by which the sea is excluded from the valleys of eastern Norfolk; and to preserve more than forty thousand acres of valuable land, to which the ocean was again asserting its claim, after having abandoned it for nearly a thousand years.

The valuable South Hetton Colliery was opened in consequence of his urgent and persevering advice to Colonel Braddyll, to sink for coal through the magnesian limestone, in opposition to the "practical" opinions of the most eminent coal viewers of the North, who were guided only by their own limited experience of

a limited district, unaided by those general principles, deduced from more extended observation, which he brought to the solution of the question.

The relations existing between the geological structure of a district and the system of agriculture pursued in it constituted a favourite point of view from which the father of English geology loved to contemplate the science which he had created; and so intimately is the natural vegetation which a soil supports connected with its chemical composition, and this again with that of the rocks from which it is derived, that by these means alone he was not unfrequently enabled to define on his maps the limits of strata when not too much obscured by the detrital deposits. An eminent agriculturist and land-agent, having heard him explain the structure of the Wiltshire hills and vales, their relation to the neighbouring districts, and the influence of this structure on the system of culture pursued on them, exclaimed, "That is the only way to learn the true nature of soils." "Even such sympathy," says Professor Phillips, the nephew and biographer of Smith, "was highly prized by the modest father of geology, who in later years, when that science had obtained a high degree of public favour, frequently recounted, among many mortifying instances of disregard, this apparently slight and solitary case of encouragement."

Fifty years have elapsed since this remark on the value of geological knowledge to practical men was uttered by a practical man; and how little progress has been made during that period in the work which Smith commenced, and which he had so much at heart—the application of geology to the improvement of the soil! This has arisen, not from the inability of geologists to afford assistance, but from the little encouragement they have received from agriculturists to pursue this course of investigation. We are now, however, at the commencement of a new era, when the economic value of science is beginning to be better appreciated. The number is increased of those, like Mr. Davis, who declared the road to the true knowledge of soils to lie through the paths of geology; like Mr. Bevan, who requested of Smith a sight of his maps and sections, when he was folding them up, disheartened at the little attention which they received at an agricultural meeting; or like Sir John Johnston, the friend and patron of Smith's declining years, who engaged his services as land-steward to the Hackness estates. Still there are many who, if they dare not now openly denounce geology as a visionary speculation, are yet in their hearts incredulous as to its practical utility. Some there are who a few years ago would have been among the scorners, but who now, when science is rising in public estimation, are willing enough to partake the triumph, and with

little knowledge of either agriculture, chemistry, or geology, are putting themselves forward as their expounders, and are expounding them in a manner not very likely to bring science into repute with practical men.

The laws which regulate the distribution of soils constitute a more complicated problem than is usually supposed. In the agricultural application of geology, we must remember the existence of the loose covering of detrital matter as well as the regular alternations of the stratified beds and irregular intrusive masses of unstratified rocks; and we must not fall into the error of exaggerating the agricultural influence of the two latter, because the former is excluded from our geological maps, which only exhibit the solid rock nearest to the surface. The detrital deposits, from their superficial position and their almost universal distribution, are of the most importance to the farmer. They not unfrequently attain a depth of several hundred feet, producing a class of soils in which the agricultural influence of the subjacent solid rocks is reduced to its minimum; and when, on the other hand, they do not exceed a depth of two feet, and that influence approaches its maximum, they include not only the soil turned over by the plough, but the subsoil, in the strictly agricultural sense of the term. In those cases in which they are the thinnest they always modify considerably the characters of the soil derived from the subjacent solid strata, and in those cases in which the detrital deposits attain their greatest development, the solid strata still exercise some influence, partly by the intermixture of their fragments in the surface soil with others transported from a distance, and partly by the beds of clay, marl, &c., derived from their ruins, and buried at greater but still accessible depths, where they furnish, to those who will seek for and use them, the means of correcting chemical and mechanical defects in the composition of the soil and subsoil. No agricultural maps, therefore, such as those appended to the Reports of the Board of Agriculture, which only exhibit, and that imperfectly and on a very small scale, the variations of the surface, and neglect those of the substrata contained in the detrital deposits and in the still deeper solid strata, nor geological maps from which those detrital deposits, except in a few extraordinary cases, are excluded, can exhibit the true agricultural relations either of an extensive district or a single estate.

Norfolk affords a striking illustration of these truths. Well defined by natural boundaries, the Ocean, the Waveney, the little Ouze, and the Nen, it forms only part of a large geological district, in which the superficial deposits, from their extensive development, assume an important agricultural character. With some interruptions from the alluvial tracts of the Humber, the

Wash, and the Yare, this district extends from the coast of Holderness, in Yorkshire, to the banks of the Thames, if not further to the south. On the western side of the watershed of England we have again similar superficial accumulations, extending from the mountains of Cumberland down both sides of the Cambrian Chain, fringing the western coast of England and Wales, and the eastern coast of Ireland, running up the hollows into the interior, and covering the central plain of the new red sandstone in the counties of Lancashire, Cheshire, Shropshire, Worcestershire, and Warwickshire, with thick beds of sand, gravel, loam, and clay, containing fragments of marine shells of existing species, and large blocks derived from far distant rocks.

Although the superficial deposits are of so much economic importance, and from their position are those which might have been expected to have first attracted attention, and although their history, if deciphered, would be so interesting, interposed as they are between that condition of nature with which man is contemporary and those long epochs represented by the great series of fossiliferous strata which preceded the existence of our race, they are those with which geologists have the least acquaintance, because they are those which they have studied the least. For a long time they were regarded, on the authority of the Huttonians, as the effect of atmospheric action and fluviatile erosion, during a long lapse of ages, on the surface of existing continents. At a later period they, as well as the tertiary strata, more recent than those of the Paris basin, were attributed by Cuvier, Smith, and others, to the Noachian deluge. "We saw," says Professor Sedgwick, in renouncing this hypothesis which he had long advocated, "we saw the clearest evidence of diluvial action, and we had in our Sacred Histories the record of a general deluge. On this double testimony we gave unity to a vast succession of phenomena, not one of which we perfectly comprehended, and under the name of diluvium classed them all together." *

While the supporters of the diluvial hypothesis were successively abandoning it as the newer tertiary strata became better known, fragments of marine shells of existing species began to be discovered in these superficial deposits, the greatest height at which they have been observed at present being nearly 1392 feet; and immediately a geological party arose who regarded them as ordinary examples of tertiary marine strata, or as the raised beaches of an era still more recent, and shut their eyes to those characters which distinguish them from the strata of any other epoch. Some dismissed them with the summary conclu-

* Sedgwick's Anniversary Address, 'Proceedings of the Geological Society,' vol. i., p. 313.

sion that they were formed not during one epoch, but many; that they had been shot off the flanks of mountain chains during successive movements of elevation, and that it was impossible to distinguish the detritus of different periods thus blended together. In this spirit of hasty generalisation, it has been too much the custom with those who have undertaken the investigation of the superficial deposits to think that they have accomplished the task by bestowing on them a new name. Hence, besides those of Detrital Deposits, Diluvium, Post-tertiary Strata, and Loose Covering of the Earth, their many synonyms of Northern Drift, Erratic Block Group, Boulder Formation, Terrains de Transport, Mud Cliffs, Tertiary Strata, Post-Pliocene Strata, Moraines, and Glacial Formation. The glacial theory of Agassiz has again attracted attention to them, and whenever they shall be studied with the same diligence and patience which have been bestowed upon other departments of geology, there can be no doubt that they will be studied with equal success, and that a rich harvest will be reaped as valuable for its economic results as for the important chapter which will be opened in the history of the earth.

The base of these deposits in Norfolk consists of a great sheet of chalk with an undulating and waterworn surface which dips under the sea to the southward of east, and rising towards the interior, attains its greatest elevation along a line which ranges from Lopham Ford, between the sources of the Waveney and the little Ouze, by Swaffham to Brancaster, and constitutes the watershed of the county, known as the Downs of Norfolk. On the eastern side of the watershed the surface consists of deposits of the erratic block group, varying in depth from less than three to more than three hundred feet. Within this area is a tract in which the Norwich, or mammalian, crag is interposed between the chalk and the erratic deposits. It is bounded on the north, the east, and the south, by the Ocean and the marshes of the Yarmouth estuary, south of which it reappears in Suffolk. Its western boundary is an irregular, and not very well ascertained line, which may be described, in general terms, as ranging from Weybourne to some point between Bungay* and Diss, ramifying among the hollows in the chalk, which appears to have broken with islands and promontories the continuity of the sea in which the crag was deposited. Beneath the greater portion of the larger area east of the

* In the map accompanying Woodward's 'Geology of Norfolk,' Bungay is made the western boundary of the crag on the south. That is the furthest point in which shells have been observed in it. It is there seen covered by the till of the erratic block group. I have traced the same kind of sands, holding the same relative position to the till, but without fossils, considerably to the westward of Harlestone. They are also seen in the upper part of the valley of the Wensum, near Swanton Morley.

watershed, the upper or soft chalk forms the base of the crag and detrital deposits. The out-crop of the strata brings to the surface along the western edge of the watershed the lower beds of hard chalk, provincially called corlk, which contains much disseminated siliceous matter, and is sufficiently hard to be used as a building stone.

From beneath this, the gault, and the representatives of the green sand—the red chalk and the carstone—successively emerge, and are succeeded by the Kimmeridge clay, which forms the base of the alluvial deposits of the Wash, and is not separated as in the south of England, by the coralline oolite from the Oxford clay, neither has it the Portland oolite above it. As the drift approaches the watershed, it gradually thins off, and loses much of that regularity of deposit which is observable in the Cromer and Gorlston coast sections, and in those of the valleys of the Waveney, the Wensum, and the Yare. It is found on the summit of the watershed, with still less regularity of stratification, and, on the steep slopes of its western escarpment, has been much more broken by denuding action.

Those who will take the trouble to compare the agricultural districts into which Young has divided Norfolk, in his map appended to the Reports of the Board of Agriculture, with those of which Marshall and Kent have described the boundaries, will find but little accordance existing between them; and it will be still more difficult to trace a connexion between any of these agricultural districts and the geological districts of any geological map extant. Neither is there any work or map descriptive of the geology of Norfolk which does not require correction in some material point. The county map of William Smith is the best. The diligence of local observers has been able to make few alterations in his boundaries of the chalk and the strata below it; and those have been occasioned by the scrupulous accuracy which induced him to map only what he had actually seen, and caused him to represent the gault in discontinuous patches, which has since been traced by Mr. Rose, as a narrow continuous band. His map of Norfolk is likewise the best agricultural map extant, dividing the county into the light and strong soiled districts which represent, with as much accuracy as possible on so small a scale, the general outline of the areas occupied by different members of the drift; by an error, however, very excusable at the time his map was published, when the tertiary strata more recent than those of the Paris and London basins were little known, he has mistaken their place in the geological scale, and has referred the drift to the London and Plastic clay series, placing the crag below the latter. To this map I shall again have occasion to refer when describing the districts into which I divide the county. Its

merits and defects will be better understood after the succession of deposits above the chalk shall have been described.

We have seen, that in the person of William Smith, geology was of agricultural origin, and was at an early period of his discoveries applied to the business of agriculture. In Marshall, one of the earliest writers on the agriculture of Norfolk, we have another proof of the intimate connexion between geology and agriculture, since he, who merely undertook to describe the practical details of the Norfolk system of husbandry, was insensibly led into the description of geological phenomena, at a time when that science only revelled in crude speculation and soared above the observation of facts.

Justice to so early an observer requires, in this paper, some notice of his geological investigations.

Marshall resided in Norfolk from 1780 to 1782, during which time he had the management of the Suffield estates. He divides the country into three agricultural districts, those of East, West, and South Norfolk. His description of the Norfolk practice is confined principally to East Norfolk, in which he resided, his knowledge of the others being acquired by occasional rides through them. The surface of East Norfolk he describes as an almost uniform flat, except in a border towards the sea-coast, which is broken, and in many places bold and picturesque; and except in the more southern hundreds, which abound in marshes and fens, or lakes and broads, some of them of considerable size. With these exceptions, he pronounces the soil as scarcely containing an acre which may not be called sandy-loam; its quality, however, differing widely, both in texture and productiveness, in general shallow, five or six inches being the maximum of depth, the northern part abounding with barren heaths and unfertile inclosures, the southern hundreds principally covered with a richer, deeper, and highly productive soil. Young, in speaking of this district, appears quite at a loss for epithets to express his admiration of those parts not occupied by broads and marshes: "The arable land is," he says, "a fine, deep, putrid, sandy loam, adhesive enough to fear no drought, and friable enough to throw off superfluous moisture, so that all seasons suit it; from texture free to work, and from chemical qualities sure to produce in luxuriance whatever the industry of man may commit to its fertile bosom." Kent calls it a fine sandy loam, equal in value to the best parts of the Austrian Netherlands, so fruitful and pleasant to work that the occupier is seldom put out of his rotation. This is almost the only district of the county respecting the boundaries of which these writers are agreed; though they differ widely in their estimates of the merits of the husbandry pursued in it.

In treating of the substrata of East Norfolk, Marshall de-

scribes the most prevalent as an "unfathomable ocean of sand," while in some places an absorbent brick earth is the immediate subsoil, marl rising occasionally near to the surface, but seldom so high as the "pan." He adverts to the existence of "scalds" in this district, as more pernicious than springy patches in cold-soiled countries, with this additional evil, that he looks upon the former as incurable, while partial retentiveness may be more easily removed. These "scalds," or spots of burning soil, he attributes to a more absorbent subsoil being interposed in patches through one less absorbent, and by "heads," or prominent parts of the substratum of sand, rising up through the stratum of brick earth in the manner that "heads of marl" shoot up towards the surface.

He notices the hard crust, provincially called the "pan," immediately under the cultivated soil, the breaking of which was then, as it is even now, in a minor degree, looked to with so much dread by the farmers of Norfolk. He regards it as a production, not of nature but of art,

"Or, to speak more correctly, a consequence of the Norfolk culture carried on from time immemorial with the Norfolk plough, whose broad flat share, being held invariably in a horizontal position, and unless in fallowing, invariably at the same depth, the surface of the subsoil becomes formed, by the action of the share, the pressure and sliding of the heel of the plough, and the trampling of the horse, into a firm and even floor upon which the soil is turned and returned, as it would be if spread on a floor of stone or other hard material."

The fossil manures of Norfolk he describes as—

1. The chalk marl of Thorpe Market, in the Hundred of South Erpingham.
2. The clay marl of Hemsby, in the Hundred of East Flegg.
3. The soft chalk of Thorpe by Norwich.
4. The hard chalk of Swaffham.

"The grand fossil manure of Norfolk is," he says, "*Marl*, through whose fertilising quality, judiciously applied, lands, which seem to have been intended by nature as a maintenance for sheep and rabbits, have been rendered capable of fattening bullocks of the largest size, and finishing them in the highest manner."

He mentions two sorts of this marl, whose geological relations I shall hereafter describe, distinct in their appearance, though similar in their fertilising qualities.

"The central and northern parts of the district abound," he says, "universally with a whitish coloured chalk marl, while the Flegg Hundreds and the sea-coast are equally fortunate in a grey coloured clay-marl."

He infers that the former had been in use for centuries, from the size of oak-trees growing in old marl-pits, while the use of clay-marl as manure seemed to be of much later date, "many

farmers being still blind to its merits, because it is not *marl*, but *clay*, by which name," he says, "it is universally known."

"The name, however, would be of little importance, were it not indiscriminately applied to unctuous earths in general, whether or not they contain any portion of calcareous matter. Nothing is marl which is not white, for notwithstanding that the county has been so long and so largely indebted to its fertilising qualities, her husbandmen, even in this enlightened age, remain totally ignorant of its fertilising properties; through which want of information much labour and expense are thrown away. One man, seeing the good effect of the Flegg clay, concludes that all clays are fertilising, and finding a bed of strong brick-earth on his farm, falls to work at a great expense claying, while another, observing this man's miscarriage, concludes that all clays are unprofitable, and in consequence is at a great expense, equally misapplied, in fetching marl from a great distance, while he has perhaps, on his own farm, if judiciously sought, an earth of a quality equally fertilising with that which he is throwing away money and time in fetching. This is a strong evidence of the utility of chemical knowledge in the investigation of fossil manures."

In describing the chalk marl of Thorpe Market, he notices the singularity of its position:—

"It does not lie in strata, as fossils do in general, nor in a continuation of rocks like chalk and limestone, but in distinct masses of different figures and magnitudes, rising with irregular heads towards the surface, and sinking to a depth of perhaps 10 and 20 feet, and sometimes to a depth unfathomed. If the abyss of sand, in which they lie buried, could be rendered transparent, these clouds of marl would, I apprehend, be seen scattered under the surface of this country in resemblance of the clouds of vapour which we frequently see in summer suspended in the atmosphere."

He then notices the variations in the composition of these masses, from an intermixture of other than calcareous matter, and adverts to the lumps of chalk and the flints which they contain, similar to those found in the chalk pits of other districts.

We here recognise geological facts correctly observed, though the fathomless ocean of sand, and the clouds of marl rising like vapour through it, are exaggerated and fanciful descriptions, and savour somewhat of the cosmological speculations of the day.

At a later period, in his 'Agriculture of the Southern Counties,' published in 1797, we find Marshall using the word *geology*,*

* Having but little acquaintance with the obsolete literature of geology, I supposed this to be the first instance of the use of the term. With the Wernerians the science was "geognosy," with Smith "mineralogy," and he styled himself a "mineral surveyor." On referring the question to those geologists the most likely to possess information on this point, I found them unable to call to mind an instance of the use of the word in any treatise older than 1799. The earliest period to which I have succeeded in tracing it is 1755. In the first edition of 'Johnson's Dictionary' of that year, geology is defined to be "the doctrine of the earth," without

and proposing the formation of a geological map for agricultural purposes, in the following words:—

"A geological map of England, shaded somewhat agreeably to the sketch I have given of Yorkshire, showing, not only its mountain upland and vale districts, but giving an adequate idea of their elevation and casts of surface, would, on the instant, be a valuable acquisition to science; and whenever the Government of the country shall turn their attention to the country itself, such a map, or maps, pointing out at sight the elevations, the casts of surface, the waters, the soils, and the substrata, as they relate to agriculture, will be found to be an acquirement of considerable value."

In the same work on the 'Southern Counties' he gives a very correct description of the physical features of the Weald of Kent and Sussex dependent on geological structure, noticing the steep escarpments of the chalk opposed to each other, the "declination" of the surface of the North and South Downs in opposite directions, and the escape of the waters of the Weald through lateral gorges in the chalk. In treating of the vale of Maidstone, he describes, under their local names, the agricultural characters of the different members of the greensand which occur there, in such manner, however, as to render it evident that he was not aware of their subterposition to the chalk, nor of the laws of stratification in general, which, by this time, Smith had worked out. His analysis, too, of the marl and chalk of Norfolk, however rude and imperfect, is an early instance of an attempt to bring chemistry to the aid of agriculture. He appears, however, to have considered the efficacy of these manures to be almost entirely due to the calcareous matter contained in them, and to have overlooked their mechanical effects in imparting adhesiveness to the soil.

In my examination of the geology of Norfolk with reference to its agriculture, I determined to confine myself to the superficial deposits, adopting from previous observers, unless when any obvious error should appear, the boundaries of the regular strata, which had been investigated by them with more minuteness than I could hope to be able to bestow upon them. To the superficial deposits belong the best and the worst land in the county. The deep rich loams of the Happing and Flegg hundreds, spoken of in such glowing terms by Marshall, Kent, and Young, which lately produced eleven quarters of wheat to the acre, and which not unfrequently yield seven or eight quarters, as well as the thin soils, which, at the time those authors wrote, were employed as

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any authority being cited. The term appears, therefore, to have been revived after having fallen into disuse. It is clearly older than the Wernerian controversy, Werner having been appointed Professor of Mineralogy at Freyberg in 1775.

sheep-walks and rabbit-warrens, declared by one of them to be the best purpose to which they could be applied, are alike members of the drift.

The questions, therefore, of which I proposed to myself the solution were the following :—

1. The laws which regulate the distribution of soils under the combined influence of the solid strata and the drift.

2. The geological relations of the marl and clay which have effected so great a revolution in the cultivation of Norfolk, whether they are peculiar to that county, or whether the landowners of other parts of England may expect to find on their estates similar means of improvement.

3. Whether the structure and composition of the soil and substrata of Norfolk would suggest any improvement in the established practice of that district.

4. The attempt to solve these practical problems could not fail to throw some light on that part of geology which is at present the most obscure, namely, the history of the deposits which immediately preceded the present condition of the earth, and the agencies which impressed upon them their peculiar characters.

In all these inquiries I trust I have accomplished something; but in this paper I shall confine myself to the two former. The third will be made the subject of a future communication. The last would be out of place in the pages of this Journal, and will be only adverted to so far as is necessary for the elucidation of the laws regulating the distribution of soils.

These laws may be thus stated :—

1. The deposits of the erratic block group indicate, in England, a long period occupied in their formation upon a terrestrial surface gradually submerged, and in their denudation during gradual re-elevation; the whole period being characterised by peculiar agencies which distinguish it from the long series of the secondary and tertiary groups which preceded, and from the modern or alluvial deposits which succeeded and are still in progress.

2. The variations of soil, in districts thickly overspread with drift, depend upon the amount of this denudation, which has in some instances caused the lower beds of the erratic block group, of different composition from the upper beds, to be the strata nearest to the surface.

3. The effects resulting from this cause have been modified by a deposit hitherto little noticed, which closed the erratic block period, and which has been spread unconformably over the denuded surface of the earlier members of that group.

4. This latest deposit, which shades off into the alluvial de-

posits, varies in depth from less than six inches to more than five feet; and its depth is dependent on the contour of the surface, which is itself a result of denudation.

5. It is frequently found resting upon rocks of all ages, without the intervention of any other member of the drift.

6. Its depth in such cases is equally dependent on contours which are the result of the denudation of those older formations effected in part during the submergence of the erratic block period, and in part during antecedent geological epochs.

In order to generalise the phenomena of the variations of soil, I knew that it was necessary to lay down those variations on a map exhibiting accurately, and on a large scale, the physical features of the district. Stimulated, therefore, by the importance of the problems, both in pure and applied geology, of which Norfolk appeared to offer the key, I did not hesitate to expend the fifty pounds, which was the utmost the Journal Committee felt justified in allotting to these objects, in traversing the county for the purpose of laying down the variations of soil upon the Ordnance map; although it was expressly stipulated, on the part of the Royal Agricultural Society, that they would not engage in a survey, and although Young has stated of the agricultural map appended to his Report of Norfolk, that he had been obliged to travel many hundreds of miles to give it as much accuracy as such a sketch was susceptible of, short of that which would have required years rather than months for its completion.

On commencing this work in the vicinity of Norwich, I found the variations of soil so sudden, so frequent, and apparently so arbitrary, that I almost despaired of reducing them to any law. I therefore repaired to the cliffs of Cromer for the purpose of studying the order of succession there exhibited, and the sequence of events indicated by it. Up to this period I had been impressed with the belief that there was little or no regularity in the deposits of the erratic block period; that they had either been formed by the violent and transient action of the sea, bursting in waves over the surface of the land, or that, if formed on a permanently submerged surface, the boulder clay had been dropped at random, in detached masses, from floating icebergs, among sand and gravel. I found, by the aid of the coast and river sections, that the upper and lower strata of the drift are distinct formations, differing in their characters, and continuous over areas as extensive as many of those occupied by the tertiary strata; possessing, in common with them, appearances which could only have resulted from gradual accumulation; while those by which they are distinguished from all other sea-born strata appear capable of a satisfactory explanation by the prevalence, during the epoch of

the drift, of an arctic climate in the temperate latitudes, of whic so much evidence has recently been collected.

No sooner had I adopted the theory of gradual submergence and gradual denudation, than all the variations of soil which had previously perplexed me were seen to be a necessary consequence of it. Each fell into its appropriate place; and in little more than a week I was able, from the contour of the surface, and even from the representation of it on the Ordnance map, to anticipate the nature of the soil which I should find in a given locality in the district lying to the north-east of Norwich. As I advanced into South Norfolk I was again at fault. Clay occurred where I expected to find sand, and sand where I looked for clay. Again I repaired to the coast sections at Gorlston, and the river sections of the valley of the Waveney, and found that these apparent exceptions were likewise a consequence of the law, and proved its truth. In East Norfolk, for instance, the denudation in the deepest valleys had scarcely cut through the sand and gravel of the upper drift down to the clay of the lower drift. In South Norfolk it had exposed large areas of this clay, leaving only outlying patches of the upper drift, and in some places had even cut through the lower drift down to the sand of the still lower crag, or through that to the chalk.

Having proceeded in this manner over the eastern half of the county, I had done enough to lay the basis of a safe induction, and much more than my agreement with the Royal Agricultural Society required, and I now passed more rapidly over the remainder, making wider traverses, and ceasing to map the surface variations. The scale of the Ordnance map is the smallest on which these variations can be shown; they vanish when we attempt to reduce it. I shall therefore illustrate them by means of sections instead of maps.

The order of succession prevailing among the supracretaceous deposits of Eastern Norfolk is shown in Sections I. and II., which also show their relations to the chalk and the lower strata which emerge from beneath it in West Norfolk.

The existence of freshwater beds and of a forest, interposed between the crag and the northern drift, which had been described by Taylor,* in his work on the 'Geology of Norfolk,' in 1827, was denied by Mr. Lyell† in 1829, who regarded the freshwater beds as a deposit in a depression of the drift, and the subterranean forest at Happisburgh, &c., as beds of lignite in the crag, between which and the drift he declared himself unable to draw a line of demarcation. At that time it was not known that the

* 'Geology of East Norfolk,' by R. C. Taylor, 1827.

† 'Principles of Geology.'

crag of Norfolk was a more recent deposit than that of Suffolk. This fact was established by Mr. Charlesworth* in 1836, and in 1837 the Rev. W. Clarke† insisted on the distinction between the Norwich crag and the detrital deposits which he still called diluvium.

On a re-examination of the Cromer cliffs in 1839, Mr. Lyell, who had adopted Mr. Charlesworth's classification of the crag of Norfolk and Suffolk, recognised the distinction between the Norwich crag and the northern drift, admitted the correctness of the order of succession established by Taylor and Woodward,‡ and the existence of freshwater beds and a forest between the crag and the drift. I have deemed it necessary to notice these facts, because the error of this eminent geologist, promulgated in that popular work, 'The Principles of Geology,' appears to have been more attractive than his correction of it in the pages of the 'Philosophical Magazine;' § since there are still many who might be supposed to be cognisant of the latter who are still incredulous respecting the correctness of Mr. Taylor's sections.

I shall now proceed to a particular description of each of the deposits above the chalk.

1. *The Crag.*

The lowest of these is the Norwich or mammalian crag. It consists of a marine or fluvio-marine deposit, of very irregular thickness, containing the bones of elephantine and other mammals of extinct species, accompanied by marine shells (mixed in some places with freshwater shells), a very large proportion of which belong to existing species. Its most constant member consists of a collection of large chalk flints 2 or 3 feet thick, imbedded in a base of ferruginous gravel and sand, resting on the chalk and mixed with marine shells. It is in this part of the deposit that the bones and teeth of elephants, and other mammalian remains found in the crag, principally occur. In other parts it consists of beds of sand and gravel, varying in depth to more than 20 feet. I have never seen shells in it at a greater height above the chalk than 10 feet. Over extensive areas it is entirely free from them. Its boundaries in Norfolk, as far as they can be ascertained in consequence of the depth of covering, have been already stated.

* 'Magazine of Natural History for 1836,' and 'Report of the British Association for the Advancement of Science for 1836.'

† Transactions of the Geological Society, New Series, vol. v., p. 360, 'On the Geological Structure of the County of Suffolk, and its Physical Relations with Norfolk and Essex.'

‡ 'Woodward's Outlines of the Geology of Norfolk,' 1833.

§ 'On the Boulder Formation, or Drift associated with Fresh-water Deposits in the Mud-cliffs of Eastern Norfolk.' 'London and Edinburgh Philosophical Magazine,' Series III., vol. xvi., No. 104. May, 1840.

In its prolongation into Suffolk it is seen to rest on the red or Suffolk crag, containing a different assemblage of fossils, which in its turn rests on the coralline crag, and that again on the London clay.

Being so extensively covered by the drift, it is only exposed in sea and river-cliffs and chalk-pits, and its beds of shells being less extensively developed than those of the Suffolk crag, are rarely used like them as a fossil manure. For this purpose those of Suffolk are largely employed, with great benefit to the light soils of that county; though the term marl applied to them increases the confusion in which the nomenclature of agriculture is involved. On the whole, the Norwich mammalian crag is of little agricultural importance.

2. *The Freshwater Beds.*

The crag is succeeded in the ascending order by ferruginous sand and gravel, and greenish blue clay, abounding with sulphate of iron and vegetable remains, freshwater shells, bones, teeth and scales of freshwater fishes, together with remains of elephantine and other large mammals. The depth of the deposit inferred from numerous sections is usually somewhat less than 10 feet. It is seen in the base of cliffs between Weybourne and Happisburgh, on the shore between high and low water. Its greatest development is at Runton and Mundesley. At the latter place the peaty deposit attains a thickness of nearly 20 feet, and with the freshwater shells which accompany it, is partly below, partly interlaced with the lowest members of the drift. I have seen patches of clay of a greenish blue colour, and containing freshwater shells and vegetable remains, at the base of the cliffs between Gorleston and Lowestoffe.

The concurrent testimony of the collectors of the mammalian remains places them in these freshwater deposits, and not in the drift. I have myself extracted three specimens from their matrix. These were, 1, a rib of *Elephas primigenius*, from ferruginous sand and gravel at the very base of the cliff near Cromer, in which some stumps of trees were rooted, and within a few yards of them; 2, a rib which I supposed to be that of *Cervus megaceros* (*Megaceros Hibernicus* of Owen), but which was lost on its way to London for identification. It was imbedded in pyritous sand and gravel, containing flattened wood, in the cliff, a little south of Mundesley, several feet above high-water mark.

Besides these I have found a large palmated deer's horn, resembling that of the *Megaceros*, the fragments of which are now under examination. Its site was a greenish blue clay and silt, resembling that of the freshwater deposits, but containing marine shells, and associated with yellow sand, also containing the usual

crag species, which is seen at low water about half a mile west of Cromer.

By the wasting of the coast considerable quantities of the freshwater deposits are annually washed into the sea. The peaty beds, and the clay impregnated with sulphate of iron, have, in some instances, been applied to the land, and always with beneficial effect.

3. *The Subterranean Forest.*

At various points on the coast stumps of fir-trees occur rooted in the sand, gravel, and clay, of the above deposit. In fresh sections of the cliffs these rooted trees are clearly seen to be covered by the mass of the drift. The forest is only visible between high and low water in certain states of the wind and tides, when the sand and shingle which usually cover it are removed. Its subterposition to the drift of the cliffs, which can only be seen where their base is free from debris, is still questioned by some geologists even since it has been admitted by Mr. Lyell. The authorities for the fact, as eye-witnesses of it, have hitherto been Taylor, Woodward, and Mr. Symons of Cromer. During my recent examination of the geology of Norfolk I have had several opportunities, from personal observation, of confirming their reports.

4. *Marine Bed between the Freshwater Strata and the Drift.*

On each side of the gap at Runton I have observed immediately above the freshwater beds the rare phenomenon, in connexion with the English drift, of a regular marine bed of shells, evidently on the spot which their inhabitants had frequented while living. On the east side of the gap the deposit contains two or three species grouped together; on the west side the bed consists of numerous individuals of a single species of a large gaping bivalve, with the two valves united. The existence of these beds is doubted by some geologists, because they did not themselves see them during a rapid tour along the coast. They are only visible, like the subterranean forest, when the base of the cliffs is clear of debris.

Three times after their discovery I visited the place at intervals of several months, for the purpose of procuring specimens, and found the beds covered. Mr. Symons, to whom I pointed out the spots where I had discovered them, and whose constant residence in the neighbourhood enables him to seize the favourable moment for observation, has since seen them several times, and has undertaken to collect a suite of specimens for examination by some competent naturalist, that it may be ascertained whether there are among them any of the extinct species of the Norwich crag. There was no intermixture of the marine and freshwater shells; they were arranged in separate beds.

5. *The Lower Drift—Till or Boulder Clay.*

Above this marine deposit occurs the till or boulder clay, the lowest member of the northern drift. It is proved to be a marine deposit by the marine shells which it contains; but they occur wherever I have observed it, in England, Wales, and Ireland, in a very different condition from those of the Norwich crag, or of the marine bed last mentioned, consisting rarely of anything but fragments, distributed with the utmost irregularity through the mass—species of different habits, the inhabitants of sandy and of muddy bottoms, of deep and shallow water, being mixed confusedly together and associated with fragments of various rocks, often little waterworn, but much scratched, derived from a number of distant localities intermixed largely with local detritus. The base through which these fragments of shells and rocks are distributed is often not very dissimilar in other respects from the London clay. The foreign detritus consists of blocks and pebbles of granite, gneiss, mica-slate, clay-slate, greenstone, porphyry, and other rocks which occur no nearer than Scotland or Norway.

They constitute the tail of a stream of detritus, traceable over a large portion of the north of Germany, the blocks diminishing in size and quantity with their distance from the Scandinavian peninsula. Besides these fragments, those of Kimmeridge clay and lias are met with, containing their characteristic fossils. Those of the London clay and carboniferous strata are more rare. The most abundant detritus consists of fragmentary chalk and chalk-flints. These are found under a variety of conditions: 1, as detached masses of chalk enveloped in the clay;* 2, as masses of fragmentary chalk collected together with little or no intermixture of other matter, and free from attrition by aqueous action; 3, as fragments sometimes quite angular, sometimes more or less waterworn, dispersed irregularly through the clayey matrix, in juxtaposition with the detritus derived from greater distances. On the flanks of those masses of chalk which have been brought together without attrition and unmixed with other matter, their materials have been rearranged by marine action after being finely comminuted and intimately combined with clay, thus producing proper marls, of various shades of white, grey, blue, and yellow. The insulated masses of chalk and transported chalk rubble are most abundant in the cliffs of Cromer, between Trimingham and Weybourne. Towards the termination of the cliffs near Happisburgh the thickness of the clay diminishes. Its upper surface sinks to below the level of the sea, and disappears be-

* One of these transported masses of solid chalk at Old Hythe Point is nearly 80 feet high.

neath the sand-hills and the alluvium of the Yare. Detached portions of the clay are, however, met with in the "hards" or "holms" which rise like islands from among the alluvial deposits. In composition this clay is somewhat different from that of the Cromer cliffs, consisting of a mixture of blue clay, such as it occurs in these cliffs, with yellow clay and sand. In this form it is the grey clay-marl of East Flegg described by Marshall. South of the Yarmouth estuary it is again visible in the cliffs between Gorlston and Lowestoffe, occupying their upper part, with a large development of crag-sand below it, and a thin covering of the sands and gravels of the upper drift above it.

Following it up the valley of the Waveney, we find it still holding the same relative position to these two sandy deposits, except where, by the denudation of the upper sand, the clay has been exposed over extensive areas in the southern hundreds of Norfolk, and over a still more extensive portion of the north of Suffolk. Oolitic detritus increases in quantity as the till is traced towards the west, in the river sections, and in the clay-pits which have been so abundantly opened throughout the district. This detritus consists of fragments of the Kimmeridge clay and other oolitic rocks, with their characteristic fossils; among which, vertebræ of saurians and the septaria of the Oxford clay, known by the name of turtle-stones, abound. Mr. Rose of Swaffham possesses an extensive collection of these bouldered fossils, and Woodward's 'Geology of Norfolk' contains a catalogue of them, with the strata from which they have been derived. The oolitic sandstones frequently occur as large unabraded blocks. The Kimmeridge clay is seen sometimes under the form of accumulated masses of its unmixed fragments, sometimes in small pieces dispersed, with fragmentary chalk, through yellow clay mixed with sand.

In the northern parts of central Norfolk, and in the ramifications of the till among the chalk, the chalk detritus increases in quantity till it constitutes the largest portion of the mass, which then is scarcely distinguishable from the transported and reconstructed chalk to be mentioned presently, as enveloped in the upper drift of East Norfolk as well as in the till. This form of till abounds in the neighbourhood of Wells, constituting the "clay" which has been so extensively and profitably used on the Holkham estates. The least chalky varieties have been found the best. In the drift of the Cromer cliffs the chalk detritus has been chiefly derived from the soft upper beds; in that of southern and central Norfolk, fragments of the lower or hard chalk prevail. The masses of transported Kimmeridge clay and chalk, associated with irregular accumulations of sand and gravel, which occur in hollows on the summit of the watershed, may be consi-

dered as belonging rather to the upper drift than to the till. On the slope of the western escarpment portions of deep beds of till again occur at the heads of some of the valleys, but from the steepness of the slope it has been more denuded than in the more level districts on the east; and the greater portion of the western valleys have been swept clean of the detrital deposits, the chalk having only a thin covering of sand. In the lower parts of these valleys the till is covered by the alluvial deposits.

The upper surface of the till is very irregular in the Cromer cliffs, as shown in Section III., its depth varying from less than 10 to 70 or 80 feet.

In the river sections of the southern and central parts of the county, and in the pits where the till rests on the sand of the crag, it is seldom that more than 10 feet of it are exposed, but large portions of its upper part have evidently been removed by denudation. Where it is deep it has not been sunk through. In the section of strata penetrated in sinking a well at Diss, as recorded by Mr. John Taylor,* its depth appears to have been about 50 feet.

6. *The Upper Drift.*

The till is generally said to be unstratified, but improperly as regards that of Norfolk, because in the least stratified portions alternations of deposits are marked by irregular seams of fragmentary chalk. These are best seen either in fresh sections, or when masses of the clay have been exposed to the wash of the sea. The face of the cliff is in general covered by a crust brought down by the rain, which conceals the stratification. In the upper drift, however, stratification is much more decided, consisting of alternating beds of sand, gravel, loam, and coarse shingle. The till passes upwards into laminated blue clay and silt, which again pass into the yellow sands of the upper drift, containing large masses of fragmentary chalk.

The till occurs but once, and that at the commencement of the period of the drift; after which, the peculiar causes, whatever they were which produced it, ceased. In the upper drift there are several alternations of the fragmentary and reconstructed chalk. These, in East Norfolk, constitute a large portion of the "marl" which has been so extensively used for the improvement of its light soils. It is found in some cases mixed with a variable proportion of blue and yellow clay and sand, in others it is sufficiently pure to be burned for lime. Among the numerous instances of lime-kilns situated on these beds of transported and

* Lond. and Ed. Phil. Mag., vol. v. p. 295; and Proc. Geol. Soc. vol. ii. p. 93.

reconstructed chalk, the lime-works near the town of Cromer and at Thorpe Market may be mentioned. Near Saxthorpe is a bed in which the transported chalk intimately combined with a bluish clay yields an hydraulic lime.

The singular contortions into which the strata of the upper drift have been thrown, particularly between Sidestrand and Old Hythe Point, have attracted much attention, and various explanations of them have been offered, none of which can be considered satisfactory. The contorted strata cover others which are perfectly horizontal, so that they could not have been caused by a force acting from below, nor by lateral pressure during movements of upheaval. I have suggested subsidence occasioned by the melting of masses of ice among which these contorted strata were formed, as more accordant with the conditions to be explained, than the hypothesis of icebergs ploughing up the bed of a shallow sea in which they stranded. Woodward, in his 'Geology of Norfolk,' has given sections of the whole line from Happisburgh to Weybourne, as they existed when he wrote; but from the waste of the coast the details are in a constant state of change. In these sections he has exhibited the contorted strata as well as they can be shown on so small a scale. I have copied from his work a representation of one of them in Section III.

Let us here pause to consider the events indicated by the succession of deposits above described; for those events have had an important influence on the agriculture of Norfolk. To geologists they will be sufficiently obvious; but in preparing this paper I labour under the double disadvantage of writing for the information of those who must be presumed to be unacquainted with geology, and of drawing conclusions of practical importance, partly from facts with which geologists are familiar, and partly from facts which are now for the first time publicly announced.

1. We have in the crag a deposit gradually formed beneath the sea by ordinary marine action, as is proved by the shells which it contains, and by the condition in which they are found.

2. The freshwater beds and the rooted stools of trees show this marine bed to have been at a subsequent period sufficiently elevated above the sea to have been covered in some parts with the deposits of rivers and lagoons, and in others to have supported a forest. The size of some of the trees proves that the surface continued in this state for a considerable period.

3. This terrestrial surface was again submerged and covered by a marine deposit. This, at its commencement (the marine bed at Runton), resembled the crag, but as the submergence proceeded, it assumed characters (the till) very different from those of any former or subsequent marine formation. The ques-

tion of the agencies which produced this difference I shall not discuss in these pages.

4. The marine deposit thus formed was again laid dry. During its elevation valleys were excavated in it, and over large areas the upper drift was stripped off with the exception of some detached masses. The change in the relative level of the land and sea during these operations must in Norfolk have exceeded 600 feet, for the forest on the Cromer coast is partly below, very little above the sea, and the highest parts of the watershed are covered with the upper drift.*

5. *Warp of the Drift.*

Over the denuded surface of the upper drift and of the lower drift, when the denudation has extended so low, another deposit has been thrown down, which has hitherto been little noticed, or has been passed over in the descriptions of geological sections under the name of vegetable mould. It appears to have been a deposit from turbid waters returning to a state of tranquillity. I have named it provisionally the warp of the drift, a name which is, however, not altogether appropriate, because, though in low situations, and on level surfaces, it resembles the warp or sediment left by the tidal waters of muddy estuaries, and is scarcely distinguishable from modern alluvial deposits; yet in other situations, far above the reach of existing streams, stones of considerable size (in Norfolk chiefly flints) are contained in it, and in the vicinity of mountain-chains, the large blocks or boulders which either strew the surface or are enveloped in this deposit appear to have been dispersed at the period of its formation. Its history is yet to be discovered. For some time after it had attracted my attention I regarded it as the deposit left by the waters under which the drift was formed, as they gradually retired during the upheaval and desiccation of the land; but in the course of my observations in Norfolk, I have met with indications of the denuded surface of the drift having become dry land before this warp was spread over it.

The point, however, which most concerns our present inquiry is, that the varieties of soil depend principally on the depth and composition of this deposit, while these again depend on the form

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* Captain Robe, in reply to inquiries made by Mr. Rose, gave these as a rude estimate of the heights of the following points:—Docking, 600 to 650 feet; Swaffham, 450; Great Massingham, 600; adding that the triangulation of Norfolk was performed with instruments too small to be depended upon for the vertical angles; and that without accurate instruments it would be impossible to class the ranges according to their relative altitudes, those altitudes differing so little among themselves. See Mr. Rose's paper in the Phil. Mag.

of the surface. But for this warp the Happing hundred would have consisted of as barren sand as any in the county. It is there often 4 or 5* feet deep, while on the higher portions of Norfolk its depth is less than 6 inches. Soils of the latter description, whether loam or clay, are called by the farmer thin-skinned.

This warp differs more or less from the subsoil on which it rests. On sands it contains a greater mixture of argillaceous matter producing a sandy loam of different degrees of adhesiveness, on clay it contains an intermixture of sand producing a clay loam, or at any rate, clays less adhesive than those of the subsoil.

The greatest height to which this deposit extends has yet to be determined. In Norfolk it has been spread, however thinly, over the highest parts of the county. The situations in which it is wanting are those which, from the form of the surface, would have been swept by currents instead of the water being allowed to stagnate over them, and to deposit its sediment. On steep escarpments it is almost wholly wanting, and in such situations the subjacent strata, whether gravel, sand, or clay, of the drift, or any member of the regular strata, exert their full influence on the characters of the soil. The following sections will illustrate the varying depths of this deposit dependent on the form of the ground.

No. IV. represents the head of a valley about a quarter of a mile wide, excavated in the drift. The intensity of the surface-line denotes the varying depth of the warp or surface-soil.

The warp is less than a foot deep on the summit of the plateau, wanting on the steep sides, and from a foot to 18 inches deep in the bottom of the valley.

No. V. represents the valley when its width has increased to half a mile, and its sides, instead of being steep, have a gradual slope.

In such cases there is a gradual increase in the depth of the warp from the summit of the plateau to the bottom of the valley, where it is from 18 inches to 2 feet deep.

As the valley expands in the lower part of its course, Section VI., a warp is found in its bottom, varying in depth from 2 to 4 or 5 feet, and gradually thinning off up the sloping sides.

Even on the summit of the hills which bound the lower part

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* The analysis by Dr. Playfair, published in a recent number of this Journal, of the soil of a field near Sutton, which produced eleven quarters of wheat to the acre in 1844, contains nothing to indicate any extraordinary fertility. Soils, however, which yield to analysis only a small proportion of those ingredients essential to the growth of our cultivated plants, become highly productive when of great depth; and this is the case not only with that under consideration, but with most of the very fertile land of the Happing hundred.

of a valley, if they are surrounded by still higher hills, the warp is deeper than in the bottom of a valley near its head.

In winding valleys a gradual slope and a deep warp are found on one of its sides, Section VII., and steep escarpments with little or no warp upon the other, and these change reciprocally from side to side of the valley.

This has evidently been caused by the action of currents of water, of which the valleys were the channels during the deposition of the warp, and which have flowed at higher levels than the existing streams, and even through valleys now perfectly dry. The phenomena are analogous to those of river erosion, in which the current is deflected from side to side, and thus produces alternately bluff banks and low alluvial tracts; wearing away the banks at the points where it strikes them, and depositing the materials on the opposite side. The extent to which the denudation has been carried further modifies the quality of the soil. When, as in Section IV., the valley through its whole course is excavated entirely on the sands and gravels of the upper drift, we have a sandy loam on an absorbent subsoil, the depth of the soil increasing as we descend the valley.

When the denuding action has been carried further so as to reach the clay of the lower drift, as shown in Sections VI. and VII., we have stronger loams upon a retentive base; soils which in their natural state are often cold and wet, but become highly productive when drained. Where the upper drift has been wholly swept off large areas, we have a warp of clay-loam, varying in depth with the form of the surface, on a subsoil of clay. Outlying patches of the upper drift, remaining on a partially denuded surface, are covered with loamy warps, varying in depth with the form of the ground, and in strength with the extent of surface of the lower drift exposed in their vicinity, while the subsoil varies from absorbent to retentive, with the depth of the outlying patches of upper drift.

These variations will be better understood from the section which I have given across Norfolk, from Sidestrand on the north to the Waveney on the south, Section II., than from any map, unless constructed on a scale much too large to accompany this paper.

Poringland Heath shown in that section, and Strumpshaw Hill, which is off the line of it, but is shown in Section I., are, in Smith's county map and sections, erroneously laid down as patches of London clay. The gravel of the upper drift, about 30 feet deep, which caps them, was evidently mistaken by him for the upper marine of the Paris basin, of which the Bagshot sands are considered the English equivalent: the blue till for the London clay, the brown and yellow varieties, with much

disseminated chalk rubble, for the plastic clay below it, and the crag for the sand and gravel which abound in the lower part of that formation. This error, as regards the outliers of Poringland and Strumpshaw, has been partially continued in the map which accompanies Woodward's 'Geology of Norfolk,' in which they are represented as detached masses of clay, instead of as detached masses of gravel upon a continuous bed of clay. Professor Phillips, in his Geological Map of the British Islands, following the authority of his illustrious relative, has extended the plastic clay over the whole district occupied by the strong soils of Smith's County Map, adding in a note, that it is difficult to ascertain the boundaries of that formation in Norfolk. After very diligent search I have been unable to find a single outlier of the London or plastic clay within the area indicated. Even their bouldered fossils are by no means abundant, and the small quantity met with occur chiefly near the borders of Suffolk.

The phenomena presented by the junction of the soil and subsoil are very remarkable. The surface of the subsoil is indented with furrows and pierced with conical and cylindrical cavities similar to those which are common on the surface of the chalk, whether covered by the tertiary strata of all ages, from the plastic clay to the Norwich Crag inclusive, or by the more recent strata of the drift, which may be called the erratic tertiaries.

Almost every excavation opened throughout the district shows this furrowed surface of the subsoil, the depth of the cavities, except in some extreme cases, varying from 2 to 4 feet. It is most striking when the subsoil consists of a bed of transported chalk or of till, but is not confined to them. The furrows abound in subsoils of sand and gravel, as well as of transported chalk and till: the cylindrical and conical cavities are best developed in the two latter, but I have seen them in sand.

Section VIII. is a sketch of the junction of the soil and subsoil over a pit of the most chalky variety of till near Langham. In this case the greatest depth of indentation is 3 feet, and the depth of warp or surface soil varies in the space of a few yards from less than 6 inches to 3 feet.

Section IX. is a sketch of the junction of the soil with a subsoil of more clayey till than the last, near Hardingham. In this case the depth of the furrows and pipes varies from 3 to 6 feet, and one of the pipes extends to the depth of 9 feet. If all the projecting points of till were removed to a level with the dotted line A B, it would give a soil with a regular depth of 3 feet.

This furrowing of the surface of the subsoil is a fact of considerable importance in pure geology, with reference to the agencies concerned in the formation of the surface soil or warp of the drift; it is of no less importance in its bearing on practical

questions in agriculture connected with drainage and evaporation, 'scalds,' deep and shallow ploughing, and subsoiling.

Brick-earth of the Nar.

I have deferred till this place the consideration of the brick-earth, or rather clay, of the valley of the Nar, and the fresh-water deposits of Gaytonthorpe, both of which appear to have preceded the formation of the warp, because it was necessary that the reader should be made acquainted with that hitherto undescribed member of the erratic block period, in order to understand its relations to these beds.

Throughout the whole depth of the upper and lower drift, the thickness of which, in some of the Cromer sections, exceeds 300 feet, no regular bed has yet been discovered containing shells of marine animals that had lived upon the spot. I have mentioned a deposit of this kind interposed at Runton, between the till and the fresh-water beds at the commencement of the submergence. The brick-earth of the valley of the Nar appears to have been formed towards the termination of the subsequent period of elevation, and to be covered only by the warp of the drift, which closed the erratic block epoch. This deposit is mentioned by Young in his report to the Board of Agriculture, under the name of oyster-shells and marine mud, used as a dressing for turnips, and of great efficacy on land that has been worn out with corn. Its fossil contents, and the area occupied by it, have been described by Mr. Rose in an interesting paper 'On the Geology of West Norfolk' in the 'Philosophical Magazine.'*

He has traced it in brickfields, clay-pits, and wells for 9 miles up the valley of the Nar, with an average breadth of half a mile; the most eastern point at which it has been observed being between Narford and Westacre. It has been named, not very appropriately, brick-earth, by which loam is usually understood, whereas it is in reality a blue clay, used in the manufacture of tiles and white kiln-burnt bricks. From the marine shells which it contains, their state of preservation, and the manner in which the species are grouped, it appears to have been an estuary deposit. The greatest height of the undisturbed clay in the valley, even near its eastern extremity, does not, according to Mr. Rose's estimate, exceed 30 feet above the level of the sea; but at a greater elevation by about 60 feet, there is in Walton Field a considerable accumulation of shells in sand and gravel, which from their broken state and the high angle at which the beds are inclined, appears to have constituted the beach of that inlet of which the clay was the deep water deposit.

* 'London and Edinburgh Philosophical Magazine' for 1836, vol. vii.

Mr. Rose still maintains the opinion advanced in his paper, that the Nar clay is not any where covered by deposits containing blocks transported from a distance. When, however, I was explaining to him my views of a threefold division of the erratic block group into lower and upper drift and warp of the drift, he informed me that since his paper was published, he had found several sections in which the Nar clay was covered by what, perhaps, might be the warp, though, for reasons which I have already stated, he objected to the term as inappropriate. I visited most of the sections indicated by him, and found them, as far as I could judge in the unfavourable state of the pits at that season of the year, to be as he described them. They are, 1, the brickfield at East Winch, where the Nar clay with fossils is covered by 7 feet of red gravel and gravelly clay, containing large unabraded flints; 2, Pentney Warren and Narford, where the angular fragments of flint are smaller; 3, a spot near Bilney Church, where 4 or 5 feet of a deposit to which he admits the term warp to be applicable, cover peat, which lies immediately upon the Nar clay with its characteristic marine shells.

The fresh-water deposit at Gaytonthorpe I shall show presently not only to be covered by the warp of the drift, but to have suffered partial denudation from it.

The shells found in the Nar clay are all of existing species now inhabiting the British seas, though they differ from those found in the marine silt of the adjoining marshes, which are the group still living in the existing estuary. They are accompanied, in some of the pits, by broken bones and teeth of the horse, elephant, and rhinoceros. If these were not washed out of some older deposits, and if the place in the erratic block series which I assign to the Nar clay be correct, it would appear that in England the rhinoceros and elephant were not entirely destroyed by the submergence which produced the till and upper drift. Mr. Lyell has shown that in America the mastodon flourished after the erratic block period. The great fossil deer of Ireland appears to have inhabited the British Isles both before and after that epoch. The auroch, or bison (*Bison priscus* of Owen), which was contemporary with the extinct mastodon, entombed in the Norwich crag and other tertiary beds of older date, has survived all these revolutions, and is still living in Lithuania, where it is preserved in one of the Royal or Imperial forests like our wild cattle of Chillingham Park.*

The Nar clay, though it has been penetrated to the depth of 40 feet, has not been sunk through. The proof of its super-

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* See Murchison's 'Geology of Russia,' and Owen's 'British Fossil Mammalia.'

position to the till is therefore incomplete. It may, however, be inferred from the fact that till has been found underlying the alluvial deposits in deep excavations in the marshes.

Freshwater Deposits of Gaytonthorpe.

About 2 miles north of the ancient estuary of the Nar there is a small parallel valley, also opening to the Wash. In this valley, and a quarter of a mile north of Gaytonthorpe, a blue clay, containing lumps of waterworn chalk, and abounding with small crystals of sulphate of lime, is worked for brick-making. No shells have yet been found in it, and in their absence it is doubtful whether it is a form of till or an estuary deposit like that of the Nar. About half a mile east of this brick-field clay has been formerly dug for agricultural purposes on the farm of Gaytonthorpe Hall, on the north side of the road, but the pit is now full of water. On the south side of the road is another pit at a higher level, still worked. In this pit several beds of clay and calcareous sand rest upon an irregular surface of a bed resembling in composition the more chalky varieties of till. The surface soil consists of a loamy warp, containing in some parts accumulations of flints of considerable size, and filling furrows and pipes deeply excavated in the calcareous sand and associated clay. The depth and extent of the several beds will be understood from the accompanying section (Section X.), which is constructed on the same vertical and horizontal scale, namely, 20 feet to 1 inch. From the spot where "bones" is written on the section, Mr. Rose has obtained a nearly complete set of the teeth of the lower jaw of a species of *bos*.

From the numerous fragments of a very thin univalve in the calcareous sand, accompanied by horny *opercula*, resembling those of a small *paludina*, and from part of a *unio* occurring in one of the beds of clay, I was satisfied that they were freshwater deposits. The specimens which I procured were too imperfect to enable me to obtain an opinion on them from an eminent naturalist; but Mr. Rose, who conducted me to the pit, and who was at first reluctant to believe them fluviatile, has recently set the question at rest by the discovery of several entire specimens of *cyclas* and one *planorbis*. Though the *species* are not yet determined, there can be no mistake about the presence of these freshwater *genera*. We may, therefore, conclude, that whatever were the causes which produced the warp, they were not in operation until the latter portion of the period of elevation, when the marine strata which had accumulated upon a terrestrial surface submerged to the extent of 600 feet at least, had been again laid dry, and had continued a terrestrial surface for a sufficient time to permit a considerable accumulation of freshwater strata near the head of a valley which was filled perhaps in its lower part with an estuary

like that of the Nar, receiving in its upper part the drainage of the high grounds on the east. The warp also was not deposited until after the cessation of those agencies, whatever they were, which were so unfavourable to animal life as to have caused the absence of regular deposits of shells through a series of marine strata more than 300 feet thick.

About a quarter of a mile higher up the valley, a gravel pit has been opened in a superficial deposit of angular flints which appears to be of the date of the warp.

The elevation of the Gaytonthorpe valley is probably somewhat greater than that of the valley of the Nar; but the obscurity still hanging over these interesting deposits will not be wholly removed till a section shall have been obtained exhibiting the base on which the Nar clay rests, and till the heights of these valleys above the sea shall have been accurately determined.

The elevation above the sea of the different points in Sections I. and II. is in a great measure conjectural (see Note, p. 465), and the proportion between the vertical and horizontal scales greatly exaggerated, in order to render the different deposits distinct. Were those sections constructed on a true scale, the vertical scale in Section I., which is the most exaggerated, should not have been greater than at present, on a base line 26 feet long.

Agricultural Districts.

The agricultural districts dependent on varieties of soil into which I divide Norfolk are the following:—

I. The alluvial district of East Norfolk.
II. The district of the deep upper drift.
III. The district of the lower drift.
IV. The district of the thin upper drift.
V. The alluvial district of West Norfolk.

Each of these consists of minor divisions. In describing the boundaries of the districts and sub-districts I shall refer to Smith's County Geological Map.

I. Alluvial District of East Norfolk.

This comprehends three sub-divisions: those of—1. Alluvial Sand; 2. Alluvial Clay; 3. Peat.

The alluvial sand consists of the Yarmouth Denes and the hills of blown sand which stretch along the coast from Eccles to Hemsby, with an average breadth of less than a quarter of a mile. Though of little agricultural value, either from the extent or quality of their surface, they are indirectly of great importance, as on the maintenance of them in their integrity depends the exclusion of the sea from the valuable portions of the alluvial district of East Norfolk.

We have already mentioned the closing of the breaches in the sand-hills by means of sand and shingle as one of the triumphs of applied geology in the hands of Smith. For three years he laboured in vain to prevail on the Commissioners of these marshes to substitute such simple means for the piles of masonry and the forests of timber which they were employing in vain. At length he induced some of them to accompany him to the shore, where he pointed out the mode in which nature had formed the barrier, and by which he proposed to aid nature in sustaining it. He showed them how a shallow sea agitated by violent storms tore up the materials of its bottom, and impelled them on the shore, projecting a portion beyond the reach of the retiring wave. He pointed out how the ordinary action of the tide during intervals of tranquillity arranged the materials thus thrown up in a gradual slope, in rolling up which the waves spent their force and found a barrier of their own formation more efficacious in withstanding their fury than solid constructions which opposed to them an abrupt resistance. The arguments thus supported were irresistible, and the astonished Commissioners exclaimed—"Oh, that none of us should have thought of this before!" Smith, now allowed full scope to follow his own plans, employed a number of carts to draw the blown sand from the highest part of the neighbouring sand-hills, arranging it in a slope of one to twelve on the side of the sea, and one to three or four on the side of the land, sealing down the sand, as he proceeded, by a covering of the heaviest shingle which he could procure near the spot, and which he had observed to remain unmoved during the most violent gales. In less than a year the breach, more than a mile in length, was stopped, and the ordinary operations commenced of drawing off the surface-water by machinery—for these marshes lie below the ordinary level of high water, and have a very limited fall at low water. The measures which Smith proposed for their further improvement have not been followed up; but his unresisting slopes have withstood the heaviest storms of the German Ocean for more than forty years; and on the practice or neglect of the lessons which he taught the Commissioners in this department of agricultural engineering depends the existence not only of the rich alluvial tract of the Yare and the Waveney, in Norfolk and Suffolk, but ultimately the question whether Yarmouth itself, the site of which was a sandbank separated from the mainland before A.D. 900, shall, in the course of those changes now in progress, of which Geology takes cognisance, remain a flourishing town, or return to the state of a sandbank again.*

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* Such is the account of the operations given by Professor Phillips, in the 'Memoirs of William Smith,' from the voluminous notes of his

2. *Alluvial Clay.*

This occupies a triangular space, the base of which is a line drawn from the canal joining the Yare and the Waveney along the course of the latter river and the Bredon Water, and thence along part of the North Denes to East Caistor. The other sides of the triangle are formed by lines extending, the one from East Caistor, about a quarter of a mile south of West Caistor and Runham to Stokesby—the other from Stokesby, passing about half a mile west of Halvergate, to the point where the canal before mentioned enters the Waveney.

3. *The Peat.*

The western edge of the alluvial clay is bordered with a peaty margin, about half a mile broad, which unites the peat districts of the Waveney and the Yare with those of the Bure and its tributaries, the Ant and the Hundred Stream.

That portion of the peat of the Waveney which is in Norfolk extends, with a very irregular breadth, varying from less than a quarter of a mile to nearly a mile, from Burgh St. Peter's to the bog in which that river rises at Lopham Ford. The peat of the Yare borders both sides of the river, with an average breadth of about a mile and a half, from the Yare and Waveney Canal to Sirlingham; above which, to Trowse near Norwich, it contracts to half a mile. The widest part of the peat of the Bure is below the confluence of the Ant and the Hundred Stream with that river, the breadth varying from three miles at its northern and southern extremities, to about a mile and a half in the centre. Along the separate course of these streams the breadth of the peat varies from half a mile to a mile on the banks of the Bure from its junction with the Ant to Wroxham—on the banks of the Ant from the junction before-mentioned to Stalham Broad—and on the banks of the Hundred Stream to Hickling and Horsey Broads. The upper parts of the Yare and Wensum above Norwich, and of the Bure and Ant above Wroxham and Stalham, as well as their tributary streams, are, in many places, fringed with peaty meadows, varying from one-eighth to one-fourth of a mile in breadth.

II. District of the deep upper Drift.

This occupies all that portion of Smith's map, tinted with the colour used by him to denote light soils, which lies to the east of

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uncle. One of the Commissioners, who remembered the proceedings, informed me that Smith laid down faggots in the first instance to aid the retention of the sand.

his strong land district. It may be divided into two sub-districts —those of the thick and the thin warp—though each of these, in point of fact, consists of many districts, separated from each other by soils of a different quality.

1. *The Sub-District of the deep Warp.*

A line drawn from Trimingham to Loddon, and another from Loddon to East Caistor, will, with a few trifling exceptions, include between them and the sea-coast all the best loams of East Norfolk, interspersed among much of a lighter and thinner staple and some sand, and among the peat which borders the rivers and broads. The areas occupied by these different varieties of soil are extremely irregular, the deep and strong loams being found in the bottoms of valleys and other low situations not covered by peat, the thinner and lighter loams occurring on the summits and upper slopes of the high ground, and the sand on steep escarpments, in the manner already explained.

2. *The Sub-district of the thin Warp.*

In the tract east of a line drawn from Trimingham to Loddon the better descriptions of loam prevail. In the other part of the eastern light land district of Smith's map there are small areas of the same description of soil in the valleys, but they form the exception, the greater portion of the district being occupied by a thin warp on the summits, or by the sand and gravel of the upper drift and crag exposed by denudation on the steep escarpments bounding the valleys of the principal streams.

III. District of the lower Drift.

This comprises the space in southern and central Norfolk marked in Smith's map with the tint denoting strong land. That map represents, with as much accuracy as is possible on so small a scale, the area throughout which the clay of the lower drift has been exposed more or less by denudation. Irregular as the boundaries are, as shown on that map, the ramifications are found to be far more irregular where we follow the denudation into its details. This district of Smith's map is divided into two by the Wensum, the smallest lying to the north of that river. The separation is caused by the denuding action having extended along that great line of drainage through the till down to the sand and gravel of the crag, a large extent of which has been exposed on the steep sides of the valley. Within each of his strong land districts there is likewise every variety of soil, arising in some cases from denudation to a similar depth, though on a

smaller scale, but more frequently from outlying portions of the upper drift, covered by a deep or thin warp, remaining on the surface of the till.

Sub-Districts.

If we divide Smith's largest district of strong soil by a line drawn from Wymondham to Attleborough, wheat and bean land, consisting of the denuded surface of the till covered by a warp of clay loam, will be found to prevail over the southern portion—the outlying patches of upper drift constituting exceptional cases—while in its northern part, and in the small district lying north of the Wensum, the proportions are reversed, the loams of the upper drift covering the greater portion, and the till being only exposed, except in artificial excavations, in the bottoms of the valleys which intersect it. In the portion of the district south of Wymondham the Suffolk plough and the Suffolk course of husbandry prevail.

IV. District of the thin upper Drift.

This comprehends the whole of Smith's light land district lying on the west of his district of strong soil. It occupies the summit level of the county, on which a thinner deposit of the upper drift appears to have been thrown down, originally, than in the eastern side. It covers also with a thin coating the greater part of those areas which, following the usual course adopted in geological maps, he has represented as occupied by the rock nearest the surface. On the summit of the watershed the drift varies in depth, from less than three feet to more than thirty. Between the chalk and the warp there are generally interposed two or three feet of rubbly chalk, mixed with patches of sand and yellow clay. This is covered, in some cases, by merely a thin sandy warp; in others by thirty or forty feet of sand, gravel, and coarse shingle, with little regularity of stratification, and having masses of transported chalk and Kimmeridge clay enveloped in them. The thin upper drift of the watershed is covered in general by a more sandy warp than is found on the lower summits; there is, however, in different parts considerable variation in the quantity of argillaceous matter contained in it. This increase takes place here, as in other districts, in hollows and situations where during the submergence water would have stagnated and deposited the finely divided matter held in suspension, while sharp sand and gravel are exposed in situations which, from the contour of the surface, would have been swept by brisker currents. These prevail in the southern portion of the district,

on the borders of Suffolk, of which it is said that a gentleman, being asked in which county his property was situated, replied, "Sometimes in the one, sometimes in the other; it blows backwards and forwards."

In the district of thin upper drift we may include the western escarpment, in which the chalk and other rocks are covered only by a warp, or by a warp upon a thin crust of gravel and sand. There, however, the thinness of the covering must be considered not as an original condition of deposit, but as the result of denudation during the period of elevation, since there is reason to believe, from the patches of till remaining at the heads of some of the valleys—till being also known to lie under the alluvium of the marshes—that this western side of the watershed was covered during the period of submergence with as deep accumulations of upper and lower drift as the eastern side; that they have been more denuded during their elevation, owing to the greater acclivity of the base on which they rested, and that the gravel and sand now in contact with the chalk were deposited after their removal, but before the formation of the Gaytonthorpe beds, and of the Nar clay, and the warp.

Towards the bottom of the valleys, and as they approach the alluvial district, they are covered by a deeper warp, which produces some small tracts of strong or deep loams, sometimes upon an absorbent, sometimes upon a retentive base, ramifying, with the contour of the surface, among tracts of lighter and stronger soil, under conditions very similar to those which have been described on the eastern side of the county.

V. Western Alluvial District.

This valuable, improved, and still improving tract is divisible, like the alluvium of East Norfolk, into two sub-districts, that of the clay or loam, and that of the peat, the former the nearest to the sea, the latter at the inland extremity of the alluvial district; but as I have merely passed rapidly across it I do not undertake to define their limits.

Sections of the alluvium are only laid open in occasional excavations. These, as recorded by local observers, are such as to indicate the gradual silting up of an estuary until the salt water was excluded and a peaty morass formed, liable to inundations of fresh water. When arrived at this state its further desiccation was effected by the embanking of tracts lying nearer to the sea.

Mr. Rose has given the following as the succession of deposits laid open in the excavation of the Eau Brink Canal, near Lynn:—

	FT.	IN.
1. Surface soil, brown clay, with sand . . .	4	0
2. Blue clay, fresh-water shells	3	0
3. Peat, containing bones of ruminants . . .	2	2½
4. Blue clay, like No. 2	8	0
5. Peat, with alder and hazel bushes, the lower portions clay, containing roots of marsh plants .	3	0
6. Dark blue clay, not cut through, a marine silt.		
	20	2½

The marine shells in No. 6. are a different group from that of the Nar clay, and are of species identical with those now inhabiting the estuary.

In a well in the town of Lynn a similar succession of deposits was found to rest on till (blue clay with nodules of chalk) twenty to thirty feet deep.

The reclaiming of this tract was commenced by the Romans. After their departure the embankments were neglected and the fens were again submerged and covered by the beds No. 2. In this state they remained till the time of Charles I., when these operations of draining and embanking were resumed, which have been prosecuted with such well-known energy and success during the last half century, and which form a striking contrast to the neglect which the alluvial district of East Norfolk has experienced. The series of deposits exhibited in the preceding section appears to indicate a condition of surface, such as may be supposed to have prevailed at Mundesley and Runton during the formation of the fresh-water deposits and the growth of the forest, before that submergence which has there left as its monument the strata of lower and upper drift more than three hundred feet thick.

The large quantity of fine sediment held in suspension by the waters of the Wash, and its effects in depositing soil in favourable situations, are strikingly exemplified by a fact observed by Smith, that the surface is the lowest on the part first reclaimed, that is, within the area embanked by the Romans, while its height increases on the outside of each subsequent embankment, the highest ground of all being a space beyond the sea wall, still overflowed by the tide.

Fossil Manures of Norfolk.

From the distribution of the soils in Norfolk under the combined influence of the solid strata and the drift, I proceed to the geological relations of its fossil manures, and to the question whether the clay and marl, which have been so largely and beneficially employed in that county, are peculiar to it, or may reasonably be expected in the substrata of other districts. In

describing the deposits above the chalk, I have mentioned those which have been used for the improvement of the soil—that is, nearly all of them. A recapitulation here may not be amiss. Taking them in the ascending order, we have—

1. The peat and clay of the fresh-water deposit below the till rarely employed, but always beneficially.

2. The till. A variety composed of the mixture of the blue and yellow till is the clay of East Flegg—the grey clay-marl of Marshall. The same, with a larger mixture of detritus derived from the hard chalk and the oolites, is extensively employed not only upon light soils, but upon the clay-loams, the wheat and bean lands of South Norfolk, and the adjoining parts of Suffolk. The blue till of Cromer cliffs, of which, on a moderate computation, sufficient to fertilize 20,000 acres is annually washed into the sea, though little used, has when used been invariably found beneficial. The farmers in the neighbourhood of North and South Repps, who have the transported chalk close at hand, cart this blue clay from Trimingham, a distance of three and four miles, paying 6*d*. the load for it on the shore, or 1*s*. at the summit of the cliff.

In a hollow in the chalk near Castleacre is a blue clay containing lumps of chalk, which appears to belong to this part of the series. Mr. Hudson has used it on a loam, by no means very light, with great benefit, particularly visible in the subsequent crops of clover. On a field at Trunch, consisting of a still better loam, Mr. Amis, now of Frettenham, spread a quantity of blue clay, the same as that of the Cromer cliffs, which a gentleman in the neighbourhood requested him to remove from some excavation which he had made. The result was, in the first instance, a splendid crop of oats, followed by a great improvement in the subsequent crops, which is undiminished after the lapse of more than ten years.

3. The most chalky varieties of till constitute the "clay" of the neighbourhood of Holkham, which is scarcely distinguishable from No. 4; the least pure varieties of the transported chalk or "marl" of East Norfolk.

4. I have already stated that some of this transported chalk is pure enough to be burned for lime, that other varieties consist of fragments of chalk mixed with a variable proportion of yellow sand and clay. "At Wighton," says Young, "I saw an extraordinary fine white marl not as commonly in globules, but more resembling the equal consistence or texture of white butter." Wighton is near Wells. I have seen similar varieties in some of the marl pits of East Norfolk; in the coast sections they are found to proceed from the flanks of masses of transported chalk, the materials of which, finely comminuted and re-arranged by aqueous action, have been mixed with a portion of clay. The globules, spoken of by Young as of ordinary occurrence, are lumps of chalk.

5. *Sand of the upper drift.*—Sand spread in a thick coat on the coarse turf is one of the first steps used in Norfolk for the improvement of peaty meadows; a department of husbandry, however, in which that county does not shine. In a few instances I have seen a ferruginous sand employed on arable land—the soil a very light and thin loam—applied to the young clover. Whether any benefit had been found to result, or whether custom had so established the use of underground manures, that sand was resorted to where clay and marl were not to be had, I know not. In the former case an analysis of the sand would be very desirable.

6. The clay of the Nar with its beds of fossil oysters and other shells.

7. The fresh-water clay and calcareous sand of Gaytonthorpe employed on Mr. Sooly's farm.

If to the substances above enumerated, we add the hard and the soft chalk, raised from the solid strata, and also the London clay, and the shelly beds of the red crag—the two latter largely employed in Suffolk — we have no less than eleven mineral manures, besides varieties of some of them, used in Norfolk and the adjoining county for the improvement of the soil, ten of them bearing the names of clay and marl.

The marl from which the light lands of East Norfolk have derived so much benefit is CHALK—either chalk alone or mixed with a slight proportion of sand and clay—raised from the undisturbed strata of chalk, or from its transported detritus imbedded in the upper and lower drift. To those parts of the district which do not possess chalk, in one or other of these forms, on the spot, and at accessible depths, it is conveyed from the chalk pits of Thorpe, Whitlingham, and Horsted, burthened in some cases with the cost of thirty or forty miles of expensive inland navigation, to which again is not unfrequently added a land carriage, from the wharf at which it is landed, of four or five miles. The rotten and weathered chalk near the surface, and on the sides of the large pipes or cavities, which is partially mixed with "uncallow," is sold to the farmers under the name of marl, not because it is better for the land than the pure chalk, but because it is unfit for burning into lime. Farmers who possess chalk pits on their land have informed me that the deeper they went the more they found the quality improve.

Wherever, then, along the range of the chalk through England sandy and light loamy soils are found, they are capable of improvements like those which have so much raised the value of similar soils in Norfolk. The different beds of chalk vary considerably in the proportion of sand, clay, and phosphate of lime which is mixed with their carbonate of lime; and it may, in some cases, be found more economical to convey chalk from a distance,

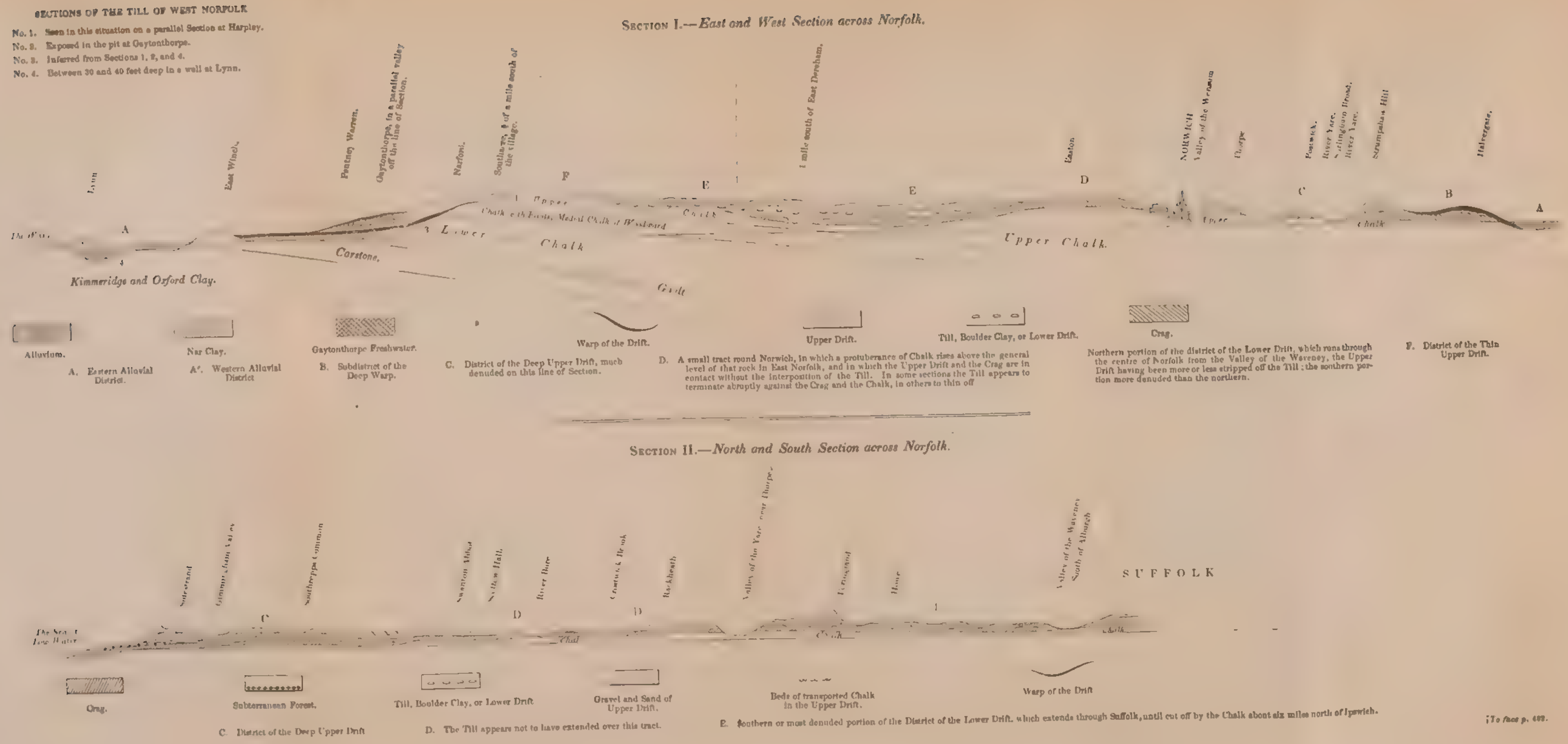
than to use that raised on the spot. An analysis of the chalk of different localities, and at different depths, is therefore highly desirable. That given by Dr. Playfair in a recent number of this Journal, of a specimen which I sent from Frettenham Common may be considered as representing the composition of the soft upper chalk of Norfolk. It contains, it will be remembered, a portion of phosphate of lime, though not in a sufficient quantity to produce the effects attributed to it in retarding for a time the action of bones, which must be due to some other cause.

Practice has not yet settled the relative merits of marl—that is to say, of pure chalk—and of clay—that is to say, of a natural mixture of fragmentary chalk with sand and clay. On this point as much contrariety of opinion prevails, at the present time, as when Young made his Report to the Board of Agriculture. Much of the marl of East Norfolk consists of a slight mixture of sand and clay in a mass composed principally of chalk; and the clay of East Flegg consists of a base of clay rendered more or less calcareous by a mixture of fragmentary chalk, the proportion of which increases westward and northward, until in the north-west of the county it differs but little from much of the transported chalk called marl in East Norfolk. There are few portions of the chalk range of England which have not been acted upon in some degree or other by the operations which produced the drift, and where deposits similar to some of those of Norfolk may not be expected. Where these natural mixtures of chalk and clay are wanting, large portions of the range are contiguous either to the tertiary clays of the London and Hampshire basins, or to the clays of the Gault, Kimmeridge, and Oxford beds. The ruins of the latter have contributed largely to the mass of the till of Norfolk; and those of the London clay enter extensively into the composition of the till of Suffolk. In those cases where mixtures of these with chalk have not been effected by nature they may be produced artificially, chalk and clay being both accessible either as regards depth or distance. Experiments, therefore, in the application of the tertiary and oolitic clays alone, or mixed with chalk in different proportions, or with lime where chalk is too remote, are well worth the trial. In speaking of its accessibility, it must be borne in mind that a Norfolk farmer does not hesitate to remove "uncallow," that is sand and gravel, from three to five yards deep, to raise an equal depth of chalk, transported chalk, or till, as the case may be; and in the pits at Thorpe-by-Norwich 20 yards of "uncallow" are removed to obtain very little more than 20 yards of chalk. The work is performed in a manner the least advantageous, small portions only being cleared at a time, the "uncallow" removed to a considerable distance in wheelbarrows, the water at a certain level kept down by hand, and the fossil

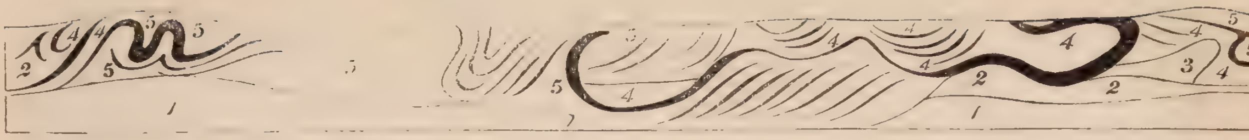
manure drawn up a steep ascent by horses in cumbrous carts. Were the operations conducted on a large scale, aided by the steam-engine and other mechanical appliances which excavators by profession have learned from the science of engineers, there can be no doubt that the same substances might be raised from depths and conveyed to distances which would now be deemed prohibitory, even in Norfolk, and that land might be improved, under such circumstances, with chalk, or clay, or a mixture of the two, at a cheaper rate than that at which most farms have been clayed or marled in that county. Nor is it only the light lands in the vicinity of chalk which would be benefited by its application. On the wheat and bean lands of the southern portion of the district of the lower drift of Norfolk heavier dressings of till are applied than on the light soils of the thick and thin upper drift in the northern, eastern, and western parts of the county; and by the testimony of all with whom I have conversed, this application of clay to clay is beneficial. This clay, however, contains a large proportion of hard chalk, and it is very probable that this is the beneficial ingredient, and that the hard chalk alone, were it accessible, would answer a better purpose.

Neither is it only in the vicinity of the chalk that these improvements are practicable. On the western side of the central ridge of England, large accumulations of the deposits of the erratic block period, as already stated, occur. The lower portion of these consists, as in Norfolk, of boulder clay derived from the grinding down of the Silurian slates, from the ruins of the lias (of which large outliers, near Whitchurch in Shropshire, attest the former extent), or from the wreck of the clays of the new and old red sandstone formations. This boulder clay is in many places highly calcareous, partly from the fragments of shells present in it, partly from the detritus of limestone rocks. On the coast sections of the long point of Caernarvonshire, fragments of the carboniferous limestone are so abundant in this clay, at some points, that they are collected for lime-burning; and even the distant chalk of the county of Antrim has contributed its calcareous matter to the mass. In the same vicinity there are sandy surfaces which would benefit largely by the application of this clay, in conjunction with the cultivation of turnips, to which they are at present utter strangers. In Cheshire also, and the adjoining counties, and, in short, wherever the upper drift extends, there are soils of sand and gravel capable of improvement by means of the accompanying clay of the lower drift, or by the clays of the stratified rocks.

I cannot close this paper without acknowledging my obligations to Mr. Rose for the information and assistance which I received from him in his own geological domain of West Norfolk.


SECTIONS OF THE TILL OF WEST NORFOLK
No. 1. Seen in this situation on a parallel Section at Harpley.
No. 2. Exposed in the pit at Gaytonthorpe.
No. 3. Inferred from Sections 1, 2, and 4.
No. 4. Between 30 and 40 feet deep in a well at Lynn.
SECTION I.—East and West Section across Norfolk.
Lynn
East Winch
Pentney Warren.
Gaytonthorpe, in a parallel valley off the line of Section.
Narford.
Southacre, ¼ of a mile south of the village.
1 mile south of East Dereham.
Easton
NORWICH
Thorpe
Strumpshaw Hill
Halvergate.
Upper Chalk
Lower Chalk
Carstone.
Kimmeridge and Oxford Clay.
Gault
Alluvium.
Nar Clay.
Gaytonthorpe Freshwater.
Warp of the Drift.
Upper Drift.
Till, Boulder Clay, or Lower Drift.
Crag.
A. Eastern Alluvial District.
A'. Western Alluvial District
B. Subdistrict of the Deep Warp.
C. District of the Deep Upper Drift, much denuded on this line of Section.
D. A small tract round Norwich, in which a protuberance of Chalk rises above the general level of that rock in East Norfolk, and in which the Upper Drift and the Crag are in contact without the interposition of the Till. In some sections the Till appears to terminate abruptly against the Crag and the Chalk, in others to thin off
Northern portion of the district of the Lower Drift, which runs through the centre of Norfolk from the Valley of the Waveney, the Upper Drift having been more or less stripped off the Till; the southern portion more denuded than the northern.
F. District of the Thin Upper Drift.
SECTION II.—North and South Section across Norfolk.
SUFFOLK
Southrepps Common
River Bure
Rackheath
Valley of the Yare near Thorpe
Valley of the Waveney South of Alburgh
Crag.
Subterranean Forest.
Till, Boulder Clay, or Lower Drift
Gravel and Sand of Upper Drift.
Beds of transported Chalk in the Upper Drift.
Warp of the Drift
C. District of the Deep Upper Drift
D. The Till appears not to have extended over this tract.
E. Southern or most denuded portion of the District of the Lower Drift, which extends through Suffolk, until cut off by the Chalk about six miles north of Ipswich.
To face p. 499.

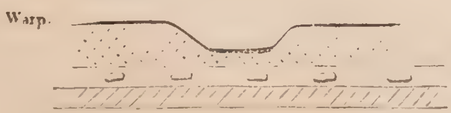
SECTION III.—*Contorted Strata of Drift.*



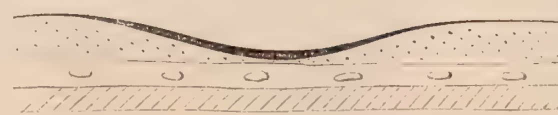
1. Till. 2. Laminated Blue Clay. 3. A mass of transported Chalk. 4. Chalk detritus, finely comminuted and mixed with Clay. 5. Sand.

The strong black lines represent contorted beds of Gravel and Loam in the Sand.

SECTION IV.



SECTION V.



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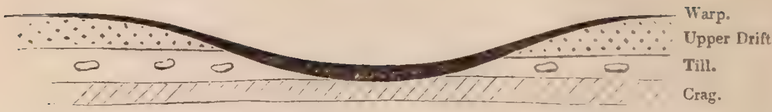

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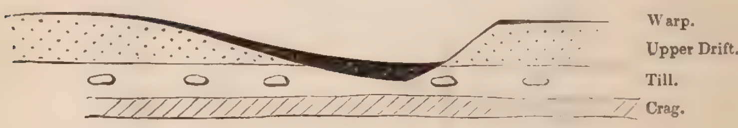
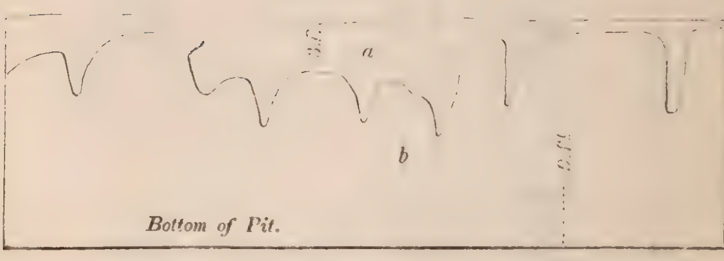


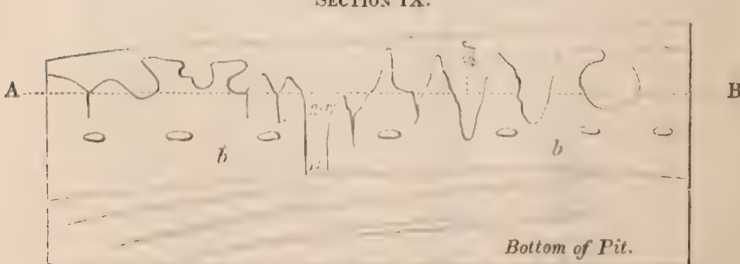
SECTION VIII.



a. Loamy Warp.

b. Flints and rolled fragments of Chalk in a base of finely comminuted Chalk and Clay.

SECTION IX.

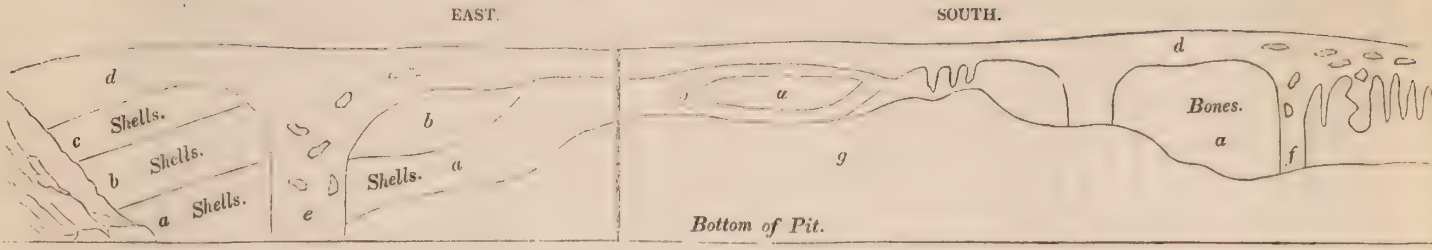


a. Loamy Warp. *b.* Till.

c. The same materials as the Till, namely Chalk and Clay, but containing irregular seams of Sand and Gravel.

SECTION X.—*Section of the Pit at Gaytonthorpe.*

Vertical and Horizontal Scale—20 feet to 1 inch.



a. Grey Clay.
b. Grey and Yellow Silt } Freshwater Beds.
c. White Calcareous Sand }
d. Warp of the Drift, Sandy Loam containing unabraded Flints. some of them of large size, as at *e* and *f*
. Drift like the most chalky varieties of Till; fragments of Chalk with Flints, and fragments of Kimmeridge Clay and other Oolitic Rocks.

XXIX.—*On the Potato Disease*, by H. Cox.

Prize Essay.

The lamentable failure of the potato crop in 1845 has given rise to many theories as to its cause; some imagining that it was a fungus; the seeds of which, being borne about in the air, were deposited on the leaves, and thence carried down with the sap into the tubers; while others contend that it was caused by atmospheric influence: for my own part, I am strongly of opinion that the latter supposition is most correct. The potato was not the only vegetable affected,—the ash, the oak, the poplar, the hazel, the vine, the apple, pear, and plum, but more particularly the walnut, the French bean, mangold wurzel, carrots, and turnips, suffered alike. We have a walnut-tree here remarkable generally for the firmness of its fruit; yet last year, out of nearly 2 bushels of its fruit, there was not one nut with the least symptom of a healthy kernel, the leaves exhibiting the same appearance as those of the potato, and that about the same time; and this tree was no more than a fair sample of all the walnut-trees in our neighbourhood. My scarlet-runner beans ceased to grow after the beginning of August. All the early varieties of turnips in the garden began to decay at the top; a splendid piece of Dale's hybrid turnips was nearly destroyed; our swedes were affected almost in the same degree as the potatoes; the mangold wurzel, particularly the orange globe, was affected at the rate of one in five; and carrots at the rate of one in eight; even the cabbage was beginning to decay when the dry weather in the third week in August set in.

I will now proceed to set down some facts relative to the potato disease, in the hope that, though they certainly do not solve the mystery, they may throw some light, however faint, on its cause and its remedy. As to what kind of potato was most injured, I think we can say nothing positive; yet certainly those varieties that were fast approaching to maturity before the ungenial weather set in, were but little if at all affected. I dug a bed of the early ash-leaf kidney the first week in August; a portion of them lay on the ground several weeks, but not the slightest symptom of disease has appeared on them up to the present moment, although for experiment sake I covered some of them with another variety that was entirely rotten: another bed, only 4 feet distant, planted from the same heap, but several weeks later in the season, was growing vigorously in July, and probably would not have been ripe until the beginning of September: these were taken up in the third week of August and laid in the sun; out of 6 pecks of these I could not find half a peck sound at the end of the week: the same remark will apply to

another variety called the Early Somerset kidney; only in this case the beds were in two different situations.

In the first week of April I planted a piece with second early kinds, called Prolific, and a few China Orange potatoes: the situation of this piece was well adapted for observation, the rows running in direct lines north and south, one end being elevated on a steep bank, and the other running into a damp flat; now the upper parts of the rows being exposed and the soil likewise being rather poor, the plants came up sturdy and grew slowly, so that there was plenty of room for the wind (what little there was) to circulate about them; consequently the tubers were in a more forward state than at the lower end of the rows. The plants in the flat, from the ground being damp and richer than the top, grew rapidly, running together in a mass, consequently had no chance either of exposing their foliage to the light or of getting dry at intervals, but were exposed to the effects of a continual damp. I marked a piece 3 yards wide across the rows at each end, and after digging and carefully collecting them, I found that those grown on the top part were slightly affected at the rate of 1 in 27; while those dug from the lower part were affected at the rate of 1 in 4. As we went further into the later varieties, the difference was not quite so perceptible; the table standing thus:

	Top.	Bottom.
Reds . . .	1 in 7	1 in 3
Purple . .	1 in 5	2 in 3
Late Kidneys .	1 in 4	4 in 5

I do not mean to say that so many potatoes were quite rotten at the time of digging; in fact, one half of them appeared sound on the outside, but finding that the disease always made its first attack on the tuber just at the end of the string which connects it with the haulm, and by which it receives its food, I cut a small piece off each tuber just under the rind at the junction, when I could readily discover, by the appearance of a light brown spot of a ragged appearance, whether putrefaction had begun; by this means I was enabled to find out which were affected, and to have them used first, so that out of twenty-six sacks of $2\frac{1}{2}$ cwt. each, I was not obliged to throw away more than 1 cwt. as absolutely useless; while many of my neighbours burned or otherwise destroyed two-thirds of their crop, and in some instances more. It has been asserted that cutting seed potatoes for planting accelerated the disease; this I could prove in numerous instances not to be the case; one instance in particular, I think, is worth notice: having to plant a piece of ground with larches, &c., that had been previously let out for growing potatoes, I had occasion several times during the season to examine it; there were in it two lots of potatoes grown side by side under two different modes

of management; one appeared exceedingly vigorous and thick, the haulm having run into a mat; they covered the ground almost as thickly as vetches; those had been planted whole, and the rows not more than 20 inches apart; it was a white variety with numerous eyes, which threw up several stalks from each tuber: in some cases I observed that the tops had grown to the length of 5½ feet, and were of course prostrated. I need not add that their leaves were all rotten before the plants were full grown, except a very few leaves on the tops; when they were taken up the roots measured 2 pecks to the rod; three out of four of which were nearly rotten, and all the remainder affected.

The other lot was planted with the same variety and at about the same time; but the man, being short of seed, had made, contrary to his usual practice, a set with nearly every eye, and planted them 30 inches by 12 apart,—that is, he put his rows 2½ feet distant from each other, and the sets in the rows 12 inches from each other; consequently, having plenty of room, the stalks grew strong and erect, and the ground was not covered with them, so that the air could circulate freely about them. This piece, although it looked what we call thin, produced 5 pecks to the rod, and not more than one tuber in twenty was the least affected. I could adduce numerous instances similar to this, but I think this sufficient to prove that cutting potatoes for sets has nothing to do with the disease in question.

It has been urged that the weather had nothing to do with the disease, because it had been known before even in the previous dry season. Certainly I have myself seen it formerly and in many instances. In the year 1842 I had some potatoes sent me for Ash-leaf kidneys, which turned out to be mixed with a variety called the Purple-cut kidney: they were planted on a piece of rich ground, and all came up strong; the Purple cuts, however, soon got the advantage of the Ash-leaf, and at last completely overran them, so that the Ash-leaf were kept perpetually in the dark and damp: the stalks of the Purple-cut variety, from being planted in a damp and rich spot, grew in some instances 8 feet long. Upon taking up the crop there appeared several dark-brown spots which spread rapidly over the potato, precisely in the same way as the spots of 1845, after being exposed to the sun. In the same year my Dutch potatoes, planted the beginning of August for the purpose of digging as a substitute for young potatoes in winter and spring, were also affected with precisely the same disorder; and I have found it in this variety for several years, which I attribute to the damp cold season setting in while the stems and foliage are in so tender a state; I have never observed it when they have been clean cut down with a sharp frost and their vegetation stopt at once. In 1843 I saw a pit

opened containing upwards of 40 sacks of potatoes which had been grown in exceedingly damp ground: there the disease manifested itself to an unmistakeable degree: out of the whole 40 sacks there were not 5 sacks sound by the beginning of February. I likewise observed the same kind of disease in an adjoining field * in the year 1829; and my father tells me that he has frequently observed it in frames and pits thirty years ago, where the heat had suddenly dropped off and the plants had been subjected to the drip.†

I will not attempt to insert a statistical account of the various localities where the disease was most severe last year; because it is almost impossible to get at a just estimation. But I have invariably found that where the situation was damp and the ground rich, the haulm being luxuriant, the crop was most affected, except in a few instances where they were planted very late and the stalks exceedingly tender; and in no instance do I know that the potatoes were affected last year, where the crop was ripe or dug up before the middle of July.

Taking the above facts into consideration, I must think that the breaking out of the disease in the potato crop of 1845 was influenced by the continual damp and sunless weather which they experienced just at the time that they required a greater degree of light and dryness; but that this ungenial weather, in the later part of July and beginning of August, would not have had so much effect upon vegetation if it had not been forced into rapid and unnatural growth by the excessive heat and closeness of the atmosphere in the months of June and beginning of July, particularly from the 3rd to the 8th of July.

The disease was simply decay, which began, I believe, in the stalks; yet first showed itself on the leaves of the potatoes about the first week in August: it had a dark livid look in spots of an oval shape all over the surface of the leaf; a few days afterwards it appeared in the axils of the leaves, exactly in the same manner as though produced artificially by the drip; from thence

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* A field called the Rudges, in the parish of Tetbury, at that time partly let in allotments for the purpose of growing potatoes.

† A continual dropping of condensed steam, or water, on one particular place. It is customary amongst many gardeners, when the heat of a hot-bed suddenly declines, to keep the frame shut close, for the purpose of keeping up the requisite temperature of the internal atmosphere: whence follows an etiolation of the plants; and if a continuance of cold wet weather follows, it is almost sure to produce a disease amongst the plants, particularly at those spots immediately under where the condensed steam collects on the roof, and drops in the shape of a continual dripping of water.

it proceeded down one side of the stem. In some cases I observed that these had lengthened in the course of 24 hours 2 inches; the first tuber I observed affected was on the 8th of August, but it was impossible to make any one believe there was anything the matter beyond what is the case every year. On the 23rd complaints came in from all parts of the country, followed next week by contradictions and assurances that the crop were healthy as usual, with the exceptions of a few spots on the leaves, and that the tuber was quite sound. Very many people deceived themselves on this point; I amongst the rest had several rows of different varieties turned out, and could discover nothing particular except a sort of livid smooth skin, which I attributed to the unripe state of the tuber. I picked out every one that I considered affected, and left the remainder on the ground during four or five warm days, when I intended to have had them taken up and stored, but on examination I found the whole of the late varieties badly affected, the warm sunshine, together with the previous dampness of the ground, favouring and accelerating the fermentation already began. This taught me to adopt quite a different method with the main crop; I immediately had them taken up and laid in small heaps two or three days, shading them from the hot sun, but allowing them plenty of air; I then had them taken into a dry loft after having had them carefully picked over: in a few days they were picked over again, after which they were stored away in different situations, for experiment sake, the result of which will be seen when we come to consider the mode of storing.

The partially diseased potatoes were boiled, the best for table, and those further advanced for the pigs, which throve remarkably well upon them when mixed with meal after being well mashed.

We now come to consider the precautions which afford the best hope of averting the disease. First, then, choose sound tubers for sets: for although it is by no means certain that diseased seed will invariably produce diseased progeny, yet it seems likely that the new plant will inherit a predisposition to decay, which would require many seasons to outgrow.

Secondly, choose well prepared ground in a dry situation and *not over rich;* this point is of great importance, as has been seen by my experiments in taking up the crop of 1845.

Thirdly. In choosing manures apply such as seem to arrest fermentation and putrefaction, such as charcoal dust, peat-ashes, &c.; for while those substances add vigour to the plant they seem not to overstimulate its growth.

In an experiment I made in 1843 on swedish turnips with charcoal dust and ashes against seven other varieties of manure, I found that the least per-centage of rotten or diseased bulbs was

7 in 100 among seven varieties of manure, which consisted of— 1, guano at the rate of 3 cwt. per acre; 2, cow-dung, 20 tons per acre; 3, refuse of manufactory, woollen dust, &c., 10 tons per acre; 4, horse-dung, 20 tons per acre; 5, bones, 20 bushels per acre; 6, lime, 30 bushels per acre; and soot, 20 bushels per acre; 7, charcoal dust, 18 cwt., and wood ashes, 2 cwt., mixed, per acre. The guano, mill-dung, and horse-dung produced the greatest weight; the pieces manured with guano and with mill-dung produced 10 in 100 that curled in the leaf and showing signs of decay; those pieces manured with cow-dung, horse-dung, and bones, produced 8 in 100 with curled yellow leaves; those pieces manured with lime and soot produced 7 in 100 with curled leaves, but not to so great extent as the others; while the piece manured with charcoal and ashes had not a diseased leaf on it; the plants throughout looked of the most healthy and sturdy growth of any in the field, and the crop, though weighing less than the crops on the more highly manured ground, weighed more than the crop manured with soot and lime, and stored in a vastly superior degree to any other part of the field. In 1844 the whole piece was planted with mangold wurzel, and the piece on which the charcoal and ashes was used could be seen to a foot by the beautiful dark and robust leaves of the plants. I have not had the opportunity of testing it upon potatoes to any extent myself, but we find in page 619 of the 'Gardener's and Land-Steward's Journal' a communication from Mr. Barns, gardener to Lady Rolle, of Bicton, stating that in some experiments he made with various manures, in 15 cases the only 5 lots of potatoes that were taken up sound were those manured with charred material mixed with a little soot and lime.

Fourthly. *Give plenty of room*, so that the air may have free access to the foliage to dry off any damp that may be lurking about it; this point is of the utmost consequence, as all my experiments and observations have fully proved to me at least. In 1845 I planted a piece of ground with potatoes, on one part of which the rows were 3 feet apart, and on the other part 2 feet from row to row; I tried this experiment not with a view to see which would be most healthy, but to decide a dispute about which would produce the best crop and the best sample. The part where the rows were 3 feet apart yielded $5\frac{1}{2}$ pecks per rod, and the part where the rows were 2 feet apart yielded $5\frac{1}{4}$ pecks to the rod; the first were affected with the disease at the rate of 1 in 60, and the second at the rate of 1 in 15.

These then seem to me the four points we have to build upon in endeavouring to mitigate though we may not avert the future progress of the disease.

With regard to the treatment of the tubers in planting, I can

say but little in addition to what I have advanced in the second part of the sixth volume of this Journal. Many plans have been recommended, such as dusting with lime, wrapping in clay and cow-dung, steeping in sulphuric acid and water, to all of which I have given a fair and impartial trial, but have found that those planted in the ordinary way have come up quite as well, and in some instances better than those to which chemical compounds have been applied.

Autumn planting has been strongly urged as a remedy, but as such will end I believe in disappointment. Neither is autumn planting in itself advisable as a general rule. It may succeed in some favoured spots, but the majority of situations are unfavourable to this mode of planting. In the first instance, land that is apt to run together and harden will be beaten so tight with the rains of winter, that it will be impossible for the tubers to swell freely; the soil likewise, being firm, will retain a large portion of water; consequently those tubers that are produced will be watery and unwholesome; and as to early ripeness, the chance is against them, as the air cannot circulate properly in the soil in that state. This opinion is not founded upon mere idle speculation or prejudice, but is the result of many years' experience, as I always make the trial of autumn planting, and on the warmest and most favourable corner I can find, but in ten years' experiments I have found the balance of crop and quality 30 per cent. on an average in favour of spring-planted potatoes.

In the year 1837-8 all my autumn-planted potatoes were entirely destroyed, although planted 7 inches deep and protected with 3 inches of litter; and in the winter of 1844-5 they were partially destroyed when unprotected by artificial covering; besides the disadvantages above referred to, there are others almost as impossible to guard against on either a large or small scale: I allude to the depredations of rooks, jackdaws, magpies, rats, mice, moles, &c., together with slugs, weevils, and wireworm. I have seldom seen a piece of autumn-planted potatoes that has not suffered materially from those causes, and in many instances even to the amount of two-thirds of the whole crop.

I planted 8 rods of ground with second early potatoes the last week in October, 1844; about two-thirds of the plants made their appearance the last week in April, and were cut down with frost. They had recovered by the third week in May, and began to grow rapidly, but the haulm was weak and unable to support itself. They continued to grow and elongate until the second week in August, when the black spots made their appearance on the leaves, and the disease spread rapidly amongst them, so much so that out of 18 pecks (for that was the produce) there were only 3 pecks free from disease in the first week of Septem-

ber, and many of these rotten afterwards. While some of the same variety, planted the first week in April, were nearly ripe by the middle of July, and were scarcely affected.

In the third week in October, 1845, I planted 20 rows of ash-leaf kidney, each row containing 13 sets; the tubers showed slight signs of disease, and were prepared by being laid in the sun and greened; all the diseased parts were cut away, and some dusted with quick-lime, some with soot, some steeped in sulphuric acid and water, and others planted without any other preparation than being greened in the sun. About 100 plants had made their appearance by the first week in March, 1846; these, notwithstanding having been partially protected with litter and boughs of evergreen trees, were cut down by the severe frost of the 12th of March. The plant was partially recovered by the middle of April, but cut down a second time by the severe frosts of the four last days of April; there were, when I examined them on the 22nd of May, 90 plants with green tops, and about the same number that had been cut down and had not resumed growing, nor were likely to do so; the tubers on some of them were as large as partridges eggs, but had evidently done growing, as the skin was set, that is, it would not easily rub off. Some of them were showing symptoms of disease, and the haulm under ground was diseased in precisely the same manner as last year, in the ratio of 3 in 4 of those that had not resumed growing. The only difference I could observe in those prepared, and those not prepared, was that those dusted with quick-lime came up rather weaker than any others; those dusted with soot had rather a darker green tint; and those steeped in sulphuric acid and water were 5 plants short of the other portions at their first appearance in March: in all other respects I could not perceive the least difference.

I think these experiments are sufficient to prove autumn planting of potatoes is not a remedy for the disease of 1845, and that it is not applicable to general cultivation.

The great point, then, to be observed in planting potatoes is to use sound seed; to get the eye healthy so as to insure their coming up strong; to get their bed well prepared in the autumn by throwing up rough, so that the soil may be well pulverized and healthy; to cover lightly so that the atmosphere may exercise a due influence over the plant; to give plenty of room to prevent the damp lurking about the lower parts of the foliage, and expose it to the beneficial influence of the sun's rays, and bring them to an early and healthful maturity; to plant just soon enough; that the plants may be up as soon as all danger of frost is over, which is not until after the middle of May, in general. I have heard many people expressing wonder that the potato tops should look so

yellow this fine weather, but those who were up and out at four o'clock in the mornings of the 11th, 12th, 13th, and 14th of this month (May), have no occasion to wonder, for, in our locality, to use the country term, the grass was as white with frost as a newly washed sheep's back. Now, the potato plant is a very tender one, and a slight frost, if it does not cut them quite down, causes a derangement in their system, and there is no doubt occasions great debility, which would tell upon it in case of a more virulent attack.

We should also keep the growing plants in an upright position as much as is possible without injuring other parts. It is well known to every practical culturist that the growth of plants is more rapid when in a vertical than when in a horizontal position. Much has been said and written against earthing potatoes, that is, drawing the soil up in ridges about their stems; but while I condemn the practice of earthing to an extent sufficient to expose the fibrous roots to danger, I have three points upon which to recommend the practice to be continued, though on a modified scale.

1st, it helps to support the stem in a vertical position; 2nd, it protects the tubers nearest the surface from the effects of the sun's scorching and greening influence; 3rd, the crop is much more easily raised, and the tubers in better condition for storing, particularly in a wet season like the last, or in very damp ground. It may have likewise something to do with the health of the tubers, for I observed in the parish of Avening last year, amongst some cottage allotments: one lot was planted wide and earthed high; the tubers in this piece were but very slightly affected, while its right and left hand neighbours were planted so close that the space between the rows would not allow of earthing without injury; the roots were nearly all destroyed. Still this difference may be attributable to early planting.

Nothing gives health and vigour to potatoes so much as constant judicious hoeing; therefore I strongly urge that this useful point also should not be so much neglected.

One more point must not be overlooked; which is cutting down the haulm as a palliative for the disease; for though we know it is not an infallible remedy, we know from experience that it sometimes has the effect of materially checking it if the disease commences above ground; but if the plant should inherit the malady from the parent tuber, cutting down the haulm may but accelerate it, as was the case with my Ash-leaves in 1846; therefore we must not be too fast in adopting this plan, as it will very much leasen the quantity of tubers, and perhaps the causes of disease may be this year internal causes,—the relics of last year. So we must first make ourselves perfectly satisfied that the parent

tuber was quite sound and free from disease when planted, before we look for relief from this practice.

I come now to taking up and storing. It is of the utmost consequence that potatoes should be harvested in dry weather, no matter how soon after the foliage begins to turn generally yellow; they may remain on the ground two or three hours after digging, but should by no means lie three or four days (unless intended for planting, when it will improve them); they should be laid in a heap in a dry situation. An open shed is an excellent place if there is one to spare; they should not remain in this heap more than three or four days without turning, when the faulty ones should be picked out: this turning will also prevent their fermenting. In four or five days more they should be either turned again or taken to the place where they are to be stored, and laid lightly and thinly. Whether in a house or pit they should be laid thin, and not suffered to ferment. It will be seen by my experiments that storing in dry materials is not sufficient to prevent disease; and I have no doubt that every one who has tried the plan has found out that potatoes stored in ashes, chopped straw, or sawdust, have a greater tendency to shoot in the spring than those stored in any other way. This early growing in the store-heap should be guarded against as much as possible, because, if they are for food, it greatly injures their nutritious properties, as well as their flavour. I found several lots of potatoes stored in dry materials, such as I have mentioned, of which the shoots had grown several inches early in February, while those thrown loosely in the corners of the room had not made the least start. This is a consideration not to be overlooked. I have seen practised a very good temporary plan of storing potatoes that will be wanted for use within a month or two after being dug; it is to lay two narrow plate-hurdles one against the other, so as to form a ridge, thus— $\wedge$; the potatoes are laid on both sides of this ridge and thatched, the space under the ridge is left open at both ends, which forms an air-flue and prevents the heap from fermenting. In case of frost this flue is stopped up with straw or fern. This is an excellent plan when shed-room is scarce; still shed-room is preferable for this reason, that they can be attended to at any time.

I will now lay before the Society a few of the experiments I have made in storing potatoes, in testing various recommendations which I have read.

Experiments with partly Diseased Potatoes, October 29, 1845.

No. 1.—171 potatoes slightly diseased (after cutting a small piece off the tail part), steeped in 1 part sulphuric acid and 80 parts water; remained in steep twelve hours, dried and packed in dry moss, kept in a dark shed; temperature averaging 42°.

Examined April 22, 1846, when the result was as follows:—

65	Quite rotten.
63	The disease not much worse than when put away, but the tubers very much shrivelled.
27	The disease had spread nearly over the whole tuber; shoots on them, about 3 inches long, half an inch of which had turned rather on the top.
16	The disease spread over more than half the tuber; shoots 3 inches long, apparently healthy, but exhibited signs of the disease when cut. Carefully planted in new soil for experiment.
171	

No. 2.—12 slightly diseased potatoes cut as No. 1, and dusted with quick-lime, laid on a shelf in a dwelling-room; temperature averaging 62°.

Examined March 3; all quite rotten, but still retaining their proper size; cut hard, and the inside of the tuber something the colour of old oak furniture.

This experiment was suggested by a gentleman who at the same time advised the labourers to swing up hurdles in their dwelling-rooms on which to store their diseased potatoes, as a means of checking the progress of decay.

No. 3.—12 healthy potatoes placed on the same shelf as No. 2, and examined same time; were very much shrivelled, and quite unfit for cooking, though the eyes were breaking strong.

No. 4.—1 bushel very slightly diseased potatoes, dusted with lime and packed in a tub with burnt earth and charcoal, placed in a dry loft, with a temperature averaging 46°.

Examined April 22; picked out half a peck, being about 1-8th part either quite rotten, or very much worse than when put away; the other 7 parts were soft and very much grown, the dry ashes having extracted moisture from the potatoes, and having thus been rendered a favourable soil for striking them by the very means proposed for their preservation.

This experiment was suggested by the Irish Commission also, and urged by others as a sure remedy for allaying the progress of the disease.

No. 5.—1 bushel potatoes taken from the same heap as No. 4, and laid in the corner of the same room, without any preparation; turned over twice in the course of the winter. About 1-20th part was diseased to a greater extent than when put away, but none quite rotten; the eyes were quite fresh, but none grown more than half an inch, though the tubers were quite soft, the dry atmosphere having absorbed much of the water from them.

No. 6.—1 bushel taken from the same heap as Nos. 4 and 5, and packed in the natural soil, not being allowed to touch each other, covered 1 foot deep in a sunless situation: the whole quantity of rain that fell on this spot after the middle of October until the beginning of March was allowed to run through the heap, having no other protection than the soil; a trench was dug all round the heap, about 9 inches deeper than the bottom of it.

Examined March 4; the disease appeared not to have progressed at all since they were put away, and the tubers were firm as when dug.

No. 7.—The remainder of the heap from which Nos. 4, 5, and 6,

were taken, was placed in a dark bin in a cellar, the temperature being nearly stationary at 44°.

Examined April 2; the disease did not progress the least, but the tubers appeared in much better condition than any other lot.

I might go on enumerating forty experiments with sulphur, lime, salt, &c., but as I found nothing capable of curing the disease, nor any nostrum that would stay its progress, I feel that it would only be wasting the valuable time of the Society were I to submit them to your consideration.

Every cultivator of the potato is aware that a dark situation is indispensable for preserving the potato fit for food; and the experience of several years, particularly the last, has fully convinced me that a cold situation is quite as much so. A perfectly dry atmosphere has been very strongly urged as being one of the indispensables in the preservation of the potato; but the whole course of my experience has confirmed me in a different opinion. I do not wish it to be understood that the opposite extreme would be advisable, but I do most emphatically assert, that if the atmosphere of a potato-house is dry enough to cause the soil on the floor to become dust, the tubers will not be so good or so firm after seven months' incarceration as they would be with a moderate degree of moisture in the atmosphere. Not being possessed of an hygrometer, I had no means of ascertaining the correct quantity of moisture contained in the atmosphere of the cellar mentioned in No. 7 of my experiments in storing; but some idea may be formed by the fact, that the earth on which the potatoes were placed lost 13 per cent. of its weight in drying.

These experiments, coupled with nearly twenty years' practical experience in house and pit-storing, have confirmed me in the opinion that no homestead should be without a good potato-house. The expense of erecting a building of this sort would be but trifling compared with the advantage of it to every one who either grow or store in a quantity for the use of the family.

I have been in the habit of storing our potatoes in a cellar (as above referred to) set apart for the purpose, during which time we have been nearly free from the complaints that have been so prevalent amongst potato-growers for the last ten years previous to 1845, and the disease of that year progressed much less in it (as may be seen by the experiments before mentioned) than those stored under any other circumstances excepting those stored in mould. Now to store a large quantity of potatoes in the soil, so that they shall not touch each other, would require a large piece of ground, and that in a situation that is not always to be found, which should be in the shade of some wall or other building that would prevent the sun from shining on the heap. Besides, there is a great deal of trouble in thus putting them away, and likewise in taking them

out. Fine weather must always be waited for. Rats and mice have free access to them, and as soon as March approaches, the tubers, in spite of shade or anything else, will begin to grow if placed in so favourable a situation for striking their roots; so that they must be moved and housed at last, for we have still four months before new potatoes become general to supply their place.

There are many advantages in having a good house for storing potatoes; 1st, they may be examined and turned over at any season, whether in frost, snow, or rain, which is generally the time when the hands on the farm can be best spared. In the winter of 1837-8, there was a great quantity of potatoes spoiled in the pits from the effects of the very severe frost of that winter. The use of them was likewise suspended, because it was next to impossible to take them in without getting them frosted. All those inconveniences would be remedied by the use of a house. 2ndly. Their quarters could always be well ventilated, a thing of the greatest importance to their well doing; for the steam or vapour emitted from the potatoes in the process of sweating is very injurious to them if kept confined about the mass, and accelerates decay in a greater degree than any other thing I am aware of, particularly where a predisposition to decay exists.

I must now bring my observations to a close, pleading as an excuse for the manner in which they are penned, that my life has been spent hitherto in the practical cultivation of the soil, and not in theory. I conclude with the hope, that by attention to the rules of good cultivation the potato may still be restored to its pristine vigour, provided we select sound tubers for sets, choose healthy soil to plant them in, give plenty of room for them to grow in, and use great care in taking them up and storing them, not forgetting a judicious selection of sorts.

XXX.—*Experiment on the Potato Disease.*—By Lord Portman.

To Ph. Pusey, Esq.

Dear Pusey,—I send you the result of my experiments on potatoes, and I will preserve the order of my letter in the last number of the Journal for convenience of reference.

Bryanston Field Potatoes planted in November, 1845.

Lot 1.	16 Bushels sound	½ bushel diseased.
2.	8½ „	½ „
3.	45 „	4½ „

The haulm of all was equally diseased. The tubers of lot 3 were of regular size though not so large as those of lots 1 and 2, which

were double the size of any, planted in the spring. The cause of the failure of lots 1 and 2 was the decay of the tubers before they vegetated, produced by the retention of moisture by the dung.

Bryanston Garden Potatoes planted in November and December.

Lot 1.	8 Bushels sound	None diseased.
2.	7 ,, ...	,,

The produce of the sprouts planted from the potatoes in the box was sound and good.

Bryanston Field Potatoes planted in April, 1846.

Lot 1.	13 Bushels sound	½ bushel diseased.
2.	49 ,, ...	9 ,,
3.	36 ,, ...	1½ ,,

Mem.—The most regular crop was produced by the eyes which had been scooped from the tubers a short time only before planting, but the rest were not deficient in crop.

Lot 4. 1 Bushel sound.

Mem.—There appeared to be almost no vegetative power in these tubers under any circumstances.

Lot 5.	105 Bushels sound	23 bushels diseased.
6.	86 ,, ...	13 ,,

Mem.—Although lot 6 appeared most early for many weeks, yet there was no difference at the time of harvest.

Bryanston Garden Potatoes.

			Bshls. Sound.	Bshls. Diseased.
Lot. 7.	Planted Jan. 2nd.	Wimborne Kidney . .	4	1½
	12th.	Ash-leaf	5	0
	Feb. 12th.	Do.	18	1½
	14th.	Wimborne Kidney . .	12	5
	16th.	Porchester	18	3
	18th.	Ash-leaf	3	0
	18th.	Wimborne Kidney . .	7	½
	18th.	Porchester	8	½
	Apr. 4th.	Ash-leaf	5	1
	6th.	Steel's Early Prolific .	1½	½
	6th.	New Ash-leaf . . .	½	1 Peck.
	6th.	Porchester	½	1 ,,
Lot 8.	. . . . 16th.	Mexico	2½	½ ,,
Lot 9.	. . . . 30th.	New Grenada . . .	¼ Peck.	⅛ ,,

Lot 10. Seedlings raised from seed sown in March, ¾ sound, ¼ diseased.

Lot 11. The produce of the tubers raised from diseased potatoes grown in 1845 was an average crop, ½ sound, ½ diseased.

Lot 12. An untenanted allotment garden was planted in May with cut sets on very good dung, and no potato produced was larger than a marble.

The conclusions at which I have arrived are—1st. That the autumn planting, at the depth of 6 inches, is the most advisable system, and that the land should be prepared by the means best suited to its quality in the preceding Spring, *e.g.* well manured for tares or rape, and turnips, that crop fed off early, and the land ploughed as soon as possible into what are called Northumberland ridges.

2nd. That no dung or manure that retains moisture should be applied to the tubers. 3rd. That in spring planting, eyes fresh scooped from the tubers are as certain to produce a crop as larger sets, but they should be planted in land well manured and in fine tilth, and not set deeply in the soil.

I will add, that the haulm of all my potatoes was attacked, and showed symptoms of disease on the same day in July; that where I cut off the haulm there was less disease in the tubers than where it was left; and that where I pulled up the haulm there was still less disease; that the small size of the tubers in lot 12 was probably attributed to the deprivation of haulm at this very early stage of their growth. The quality of my whole crop was regular, and clean and good, and, having been housed in the store-house exactly as in 1845, has shown similar improvement, and is keeping well. The size of the tubers is two-thirds of the average growth of former years.

I hope these facts may be useful, and tend to the future improved management of the potato crops.

Yours truly,
PORTMAN.

Bryanston, Oct. 29, 1846.

XXXI.—*On the Advantages and Disadvantages of Breaking up Grass Land.* By JOHN CLARKE, of Long Sutton, Lincolnshire.

THE great and benevolent idea suggested by this subject, the conversion of grass lands into tillage, is the extent of the provision to be made for the food and employment of the rapidly-increasing population of this country.

It is necessarily incumbent on the producer, the landowner, and the occupier, to exert every energy to make the soil productive; and they conjointly are in duty bound to do so, even to the very utmost of its capability. The landlord ought to give every reasonable facility to this end, and the tenant must not be niggardly in his expenditure to promote improvements in its culture. As it is his duty, so is it to his advantage; nothing pays him so well as a judicious application of his capital to the soil he cultivates; land must be kept in a good state of culture, or certain loss ensues; bad farming is ruinous to landlord and tenant; capital must be liberally expended to bring liberal returns—productive remunerating crops. By this course the tenant is continually creating property in the soil by his own capital; and his landlord ought to afford him every encouragement for this purpose, and every opportunity to secure a favourable return for his outlay. This happily, in the present day, is the case: the under-

standing between landlord and tenant has become one of mutual good feeling, and vast improvements have been the result, and are still progressing. One amongst the many laudable efforts now making for the benefit of agriculture is the attempt to abolish the old prejudices relative to breaking up grass lands : these ignorant prejudices have long been the burthen and bane of every lease, of every old covenant, and they must be abandoned; for few deviations from obsolete practice can be so beneficial as the conversion of inferior pasture lands to tillage, and indeed, for special uses, it may be desirable to include some of the very best grazing fields. These however, as a whole, are so valuable under pasture that but few inducements can be offered of sufficient importance to warrant their being so broken up. The question, however, may be asked, what is inferior grass land, or land of medium quality? In this neighbourhood every acre that will not fatten a well-bred sheep, of any breed, is inferior grass land ; and every acre that will fatten such a sheep, but not a well-bred ox, is merely land of medium quality; land of good quality, or "good meadow or grazing-ground," will fatten either.

The Advantages of Breaking up Grass Lands.

There can scarcely remain a doubt respecting the propriety or profit of such a course, the advantages are so many and great, and the disadvantages so few. All lands of medium or even inferior quality will produce, under proper management, more animal food for man, and yield a good crop of corn alternately into the bargain. Nearly all these lands will produce more profit under arable culture, if confined simply to grow food for cattle, sheep, &c., than when under pasture; for such is the extraordinary growth of the best artificial grasses, and the many varieties of edible and esculent roots, that a far, very far, greater abundance of food, suited to every season of the year, might be thus produced, than could be grown spontaneously from the natural grasses, and of a more nutritious and fattening character. This practice, however, is not adopted, because the alternate course of husbandry is so much to be preferred. Land of this quality will not graze, to say nothing of fattening, more than from three to four sheep per acre, taking the whole year into account; but break that land up, pare it thin, and burn in the month of June, having taken part of the summer's grass, spread the ashes evenly, plough, and sow with rape or turnips, and it will be found that the first year's produce will yield food of exceedingly nutritive quality, capable of fattening 12 sheep per acre, *i.e.* it will readily keep 10 sheep, weighing from 20 to 24 lbs. per quarter, for 16 weeks; and the condition of this land may be easily kept up if necessary, but in this state being too rich for wheat, it may be re-

duced by other cropping, as in the Lothians, by taking oats, two crops being taken successively if requisite. If an alternate course is pursued, such as taking oats, clover, wheat, and fallow well manured for turnips or rape, then it might with common attention go on without limitation as to time, producing more food for stock than it did under grass. At the same time, crops of grain for the public good being the main object, it becomes worthy of consideration as to how far this should be carried out.

Unquestionably some of the best grazing-lands, possessing a deep open friable loam, make astonishingly good arable lands, yielding excellent crops of corn for many years in succession; and if kept clean and properly manured, would rarely, if ever, require a fallow or fallow crop for feeding. In proof of this assertion, the following extract from the *Tithe-Book* kept by the lessees of the tithes in the parish of Long Sutton, Lincolnshire, will show the course of cropping pursued for 20 years in a small field of about 4 acres without diminishing its fertility, so long as it was supplied with manure. This field the writer saw broken up; it has been under his observation throughout; the crops have been uniformly good, and the mustard and wheat crops splendid. The land naturally was never considered first-rate, but being for the most part of the term in the occupation of a veterinary surgeon, it was supplied with stable dung. It was broken up from grass in 1826, and has borne cropping as follows:—

1826.	1827.	1828.	1829.	1830.
Mustard.	Mustard.	Mustard.	Mustard.	Wheat.
1831.	1832.	1833.	1834.	1835.
Mustard.	Mustard.	Mustard.	Mustard.	Potatoes.

1836.	1837.	1838.	1839.
Half Wheat, half Potatoes.	Half Wheat, half Potatoes.	Half Wheat, half Potatoes.	Half Wheat, half Potatoes.
1840.	1841.	1842.	1843.
Half Wheat, half Potatoes.	Half Wheat, half Potatoes.	Half Wheat, half Potatoes.	Half Beans, half Potatoes.

1844.	1845.
Wheat.	Potatoes.

The mustard was the brown variety, and allowed to seed, which is so far thought to be exhausting that no landlord will permit it to be taken. The field is still undergoing the same course of crops.

The profitable production of food for man being the grand and ultimate object in agriculture, the conversion of such lands into tillage would easily and readily be compensated by *the hovel, the hammel, or fold-yard mode of soiling or feeding*—part of the food thus fed being grown on the arable lands, such as clovers,

seeds, &c., aids them in their course: these, the artificial grasses, are produced in greater bulk and abundance than the natural grasses: thus more food is obtained, it causes much profitable labour, the animals thrive faster, large quantities of manure are made to be returned to the lands, so that good results in every way.

The somewhat novel but certainly beneficial mode of fattening cattle, sheep, &c., on grass seeds by help of linseed cake has already in a great degree superseded the most valuable uses to which the best summer-fed pastures were commonly applied, *i. e.* to provide a supply of meat in the months of June and July, just in the intermediate time when the turnip-fed stock ceases, and before the general run of grazing lands yield their return. Latterly this summer grazing has been comparatively unprofitable, the cake-fed animals on clovers, grass seeds, and the like, having come into competition with it.

On these grounds it may be seen that the best lands might, without detriment to the public welfare, be appropriated to arable culture. They would, in fact, be far more beneficial under tillage. It is land of this quality which is so much sought after by woadmen, chiccory growers, peppermint distillers, and for such uses the deeper the loam the better. For these purposes, in this neighbourhood, land will frequently fetch from 7*l.* to 12*l.* per acre for a term of years. The rent is certainly high, but as these crops exhaust without yielding manure, the wisdom here displayed is of a problematical character.

Disadvantages of Breaking up Grass Land.

These are comparatively few. It would be disadvantageous to break up those lands certainly of first quality, possessing a good deep loam, but resting on a subsoil of heavy clay. These heavy loams do not make first-rate arable lands, but in mild and showery seasons are equal to any as pasture-grounds, carrying an abundance of stock which thrive and fatten exceedingly fast: such should remain under grass.

There are many lands, though not of first quality, yet possessing a sweet nutritive herbage well adapted to the rearing of young stock. Where such are attached to breeding or dairy farms, the proprietor ought to pause before he grants permission to break them up. Even inferior lands situate near the larger towns, or wherever required for convenience or special uses, ought to remain in pasture. All the mountain pastures, the cold clay uplands, and low swampy valleys, which, under ordinary circumstances, will not, from their local situation, pay the extra expense of tillage, must be left in grass—not, however, to be neglected, but to be drained and improved as much as possible. Where the locality

is favourable, where they can be reached with facility, all the inferior soils will pay best under culture; and if not required for any specific purpose, they ought undoubtedly to be broken up, as being better for the labourer, the farmer, the landlord, and the public.

The Labourer.—To the labourer the breaking up grass lands is of especial advantage, as affording vastly extended means of employment. In the commonest process of breaking up grass land much labour is unavoidably expended. It is indispensable to good culture that it be thoroughly underdrained: this must be effected prior to its conversion into tillage. Every useless hedge, crooked fence, old pollard trees, bushes, furze, or other obstructions, should be removed; every inequality of surface levelled down, and hollow filled up, so that the ploughs may work steadily. On many lands it is necessary to adopt the paring and burning mode of breaking up. These and many other little preparations are general upon turning pasture land into tillage. The great advantage, however, is in the regular daily labour to be done throughout the year. This will cost upon an average, as shown by the annexed table, from 42*s.* to 65*s.* per acre; and is incurred in the various operations connected with arable culture, which, compared with land under grass, is in favour of the labourer as about 4*s.* to 50*s.* per acre, or nearly 1200*l.* per cent. more is expended on arable than pasture land.

For labour expended in shepherding (including sheep-shearing and care of wool), weeding, &c., an acre of grass land, will not exceed an average of 4*s.*; but the labour expended on an acre of arable land will be as follows:—

	Wheat.			Spring Corn.			Fallows.		
	£.	*s.*	*d.*	£.	*s.*	*d.*	£.	*s.*	*d.*
To manual labour in ploughing, per acre .	0	2	0	0	2	0	0	9	0
Do. Harrowing, scarifying, and drilling	0	2	6	0	2	6	0	10	6
Do. Hoeing, draining, tending, weeding	0	6	6	0	6	6	0	13	6
Do. Harvesting, including the cutting, stacking, carting of corn crops, and the drawing, leading, cutting, and carrying out turnip crop	0	15	6	0	17	0	0	18	6
Do. Leading to barn, thrashing, dressing, and delivering to merchant	0	12	6	0	11	6			
Do. Fallow management, including manure loading and spreading on land, picking, and twitching		...			...		0	10	0
For sundry labour in hedging, ditching, shepherding, &c. &c. &c.	0	2	6	0	2	6	0	3	6
	2	1	6	2	2	0	3	5	0

		£.	*s.*	*d.*	
Labour expended in Wheat crop is . .		2	1	6	per acre.
Do.	Spring crop . .	2	2	0	do.
Do.	Fallows and crop . .	3	5	0	do.

The labour laid out upon arable land, then, is about twelve times more than is expended on pasture lands, so that it is surprisingly to the advantage of the labourer as a means of profitable employment, but it is also of great advantage to *the farmer.*

The Farmer.—To the farmer it is also of great though not equal advantage. Inferior grass lands will yield him adequate returns under good culture, but the better the land the greater the benefit. Tillage lands are managed with less capital, and are more productive. Land that will graze 4 sheep per acre will, under good tillage, yield 4 quarters of wheat per acre, or 8 quarters of oats, or 6 quarters of barley, every fourth year in rotation; and in the alternate years it will feed, first on rape or turnips, 10 sheep per acre, and on clover or grass seeds 9 or even 10 sheep per acre; but suppose this land will feed upon the average 16 sheep per acre in four years on grass, it is evident that, under proper culture, it will feed the same number in two years, and in the other two alternate years produce the crops of grain, so that the farmer produces as much mutton in the four years, and has his two crops of corn into pocket, excepting the difference in the cost of labour, and wear and tear of his implements. It is the practice of one farmer in the writer's neighbourhood to seed down without a crop: his custom is to fallow. After well working and clearing his land till the latter end of July, and having obtained a fine tilth, he then sows 1 sack ryegrass, 14 lbs. white clover, 2 lbs. parsley. In September it is forward enough to stock, when a moderate number of sheep are turned in for a few weeks. It is rested in winter, and in the spring he usually grazes from 10 to 16 sheep per acre, nearly all of which he sends fatted to market during the summer. This it will accomplish for two years, having a slight coat of dung the second winter. The soil is a sandy or silty loam of poor quality. What can inferior grass land do to this? The writer of these pages broke up, in the year 1830, a small field of 7 acres old worn out meadow, the produce averaging not more than three quarters of a ton of hay per acre. The following is the course of cropping since that time; and the crops uniformly good, except the beans of 1842. In the year 1832 the wheat yielded 56 bushels per acre:—

1830.	1831.	1832.	1833.	1834.
Oats.	Oats.	Wheat.	Beans.	Wheat.
1835.	1836.	1837.	1838.	1839.
Peas and Beans.	Wheat.	Barley.	Clover.	Wheat.
1840.	1841.	1842.	1843.	1844.
Swedes (27 tons per acre).	Wheat.	Beans.	Wheat.	Barley.
1845.	1846.			
Peas.	Wheat, looking beautifully.			

And this very heavy course was pursued, with the best results, upon a piece of poor exhausted grass land, the soil an alluvial loam of mild texture. Its fertility has been kept up by repeated but moderate supplies of manure, and thorough cultivation upon every returning season. Another field of 12 acres, in the writer's occupation, was broken up in the year 1831, and a still heavier course of crops taken, but without exhaustion; and at the present time it is fully capable of sustaining a similar course, with the usual adjuncts of good management and good dung.

A large breadth of land of medium quality, near the writer's residence, has within the past few years been broken up. The tenants, when under grass, stocked them thus:—In one case 5 hoggets per acre, and a young steer to 5 acres, and in the winter 1 shearling per acre; in another case 2 ewes suckling lambs, and 2 hoggets per acre, and a young steer to 3 acres; in other cases the same or very similar courses were pursued, the land carrying about 1 sheep per acre in winter. These lands have been broken up and planted with potatoes the first year. The labour expended in the setting and lifting these crops has been great, but the produce has abundantly repaid the outlay—the crops averaging from 350 to 600 bushels per acre of Regents and other not very prolific but very marketable varieties. These have been fallowed with wheat, which course, under ordinary care, may be thrice repeated. Inferior grass lands cannot do anything in comparison! The return upon grazing such land is trifling, but the profit under culture is ample; and they can with comparative ease be kept up to the mark, or in truly good heart, as already shown, and must in this state be worth more to rent as arable than as pasture lands. By adopting the usual course of seeding, they may be made to produce *much more* animal food for the consumption of the public than before. Lands of first-rate quality pay still better. The crops of brown mustard are frequently very valuable; and though the price is fickle—having varied, within the writer's recollection, from 8*s*. to 50*s*. per bushel—yet it is good policy on these lands to take a crop or more previous to wheat, which usually succeeds it, and often repeated to an incredible extent. The writer can point out several fields which have had 3, 4, and one as high as 6 crops of wheat in succession;* he in one instance had 2 crops successively, averaging 46 bushels per acre, and many similar facts might be mentioned, and these have continued under cropping without in any great degree impairing the fertility of the soil: indeed, after taking *woad*, it is a common practice to keep on cropping for many years, only

* One field has sustained forty-five years' cropping without a fallow or fallow-crop.

varying the rotation, and with excessive yields. Lands of this quality can readily be replenished, and their productive powers kept up.

It is, in fact, impossible to prescribe bounds to the productive powers or capabilities of such soils, if kept clean, properly cultivated, and supplied with dung. It is an important inquiry whether such lands should, under any circumstances, remain under grass? They are exceedingly valuable as pasture, but, under culture far more so, and the expense of labour in cultivation being by no means excessive, a great amount of food is produced at a small cost to the farmer. It is objected—that these lands, being capable of producing so much animal food, ought not to be disturbed. The converse of this is, however, the case:—the better the land the greater the produce under arable culture. It might be shown very readily, that if such lands were merely and solely devoted to the growth of the best artificial grasses, and these mown and given to cattle or sheep in *hammels* or *byres*, the result or proof in weight of beef and mutton would be quadrupled, and the manure thus made would keep it in fertility. It must be remembered that the lands here alluded to are the deep, open loams—not the loamy clays; these may probably be best under pasture, but the deep friable loams ought to be brought into cultivation, and would in such way best pay the tenant, and yield a higher rent to the landlord.

In respect to the *very poor* or *inferior grass lands*, it may be questionable how far they will pay for cultivation: that they are of but little value under grass is very certain; the cold and wet mountain-pastures, and low swampy valleys or lands incapable of efficient drainage, cannot be brought into profitable culture; but the cold, heavy, and thin clays, moor-lands, and heath-lands, &c., will, under the alternate course of husbandry, be most profitable to the farmer, supposing their locality easily accessible. The heath-lands of Lincolnshire, which are synonymous with the down-lands of the southern counties, have, by judicious cultivation, become some of the most productive in the kingdom. One recently brought into cultivation (Welby-warren, near Grantham) is now producing beautiful crops of turnips, barley, seeds, and wheat.

Cold clays will produce remunerative crops under proper rotations and good drainage. The farmer will find it to his advantage to cultivate such, rather than continue them under grass, and he can command the necessary aid to render them productive, which is chiefly through pulverization and the due application of rape-cake, or other artificial manures. The late Lord Leicester's property in East Norfolk was of very little value before he commenced its improvement; it let for about

2*s.* 6*d.* to 7*s.* per acre; nearly all its productive powers have been supplied by its spirited cultivators, who have succeeded in making it one of the finest estates in the country—the soil is nearly all a sandy loam. If, then, soils of such poor and varied character can be cultivated with advantage to "the farmer"—the tenant—it must of necessity be of advantage to the landlord.

Landlord.—The landlord must unquestionably be benefited whenever it is requisite for good culture to supply the land with artificial aids, either in management or manures. All inferior soils require these aids, and being thus improved by culture, will always command an equivalent rent. It is solely in lands of first-rate quality that a landlord can suffer loss. Such lands, instead of requiring aid, require exhausting in some degree, when broken up, before they can be truly profitable as corn-lands; the straw being too luxuriant, will lodge and prevent the grain from properly filling: but the loss in this case is not in rent. Land of this quality will always, if in proper culture, be worth as much to rent; the loss is in the fee-simple; it is not so valuable for sale as when under grass, but if the extraordinary demand for such land for purposes already named, as for woad, chiccory, &c., is taken into account, and for such uses fetching so high a rent, it will at once appear that the landlord in this case is also benefited, by permitting it to be broken up; the landlord then, as well as the farmer, is advantaged by the change, and the public shares in the arrangements.

The Public.—That it is of advantage to the public there cannot be a doubt, from the large supply brought to market. The necessity incumbent on the farmer to keep his land up to the mark, in order that he may be able to produce his crops in the highest state of perfection, will always prevent its impoverishment —and the farmer must do it—he must farm well to secure a profitable return; this is an unequivocal axiom in agriculture; no apprehensions need arise on this ground.

It is almost superfluous to attempt to show a fact so self-evident as that land under culture will produce more food for man than in its natural state. It has been so from the time of Adam—to whom it was said, "in the sweat of thy face shalt thou eat bread" —to the present. It was proved by the late Board of Agriculture in the year 1801, in obedience to a requisition from the House of Lords. The Board ascertained that an acre of *clover, rape, tares, turnips, cabbages,* or *potatoes,* will produce at least twice as much food as the same acre under grass of medium quality, and that the same acre would maintain at least as much stock as when under grass, besides producing every alternate year a valuable crop of corn and straw for the consumption of the cattle. An acre of land of first-rate quality, feeding or grazing

the usual number of cattle and sheep, will produce in one year a return of about 6*l.* per acre, *i. e.* it will fatten 9 oxen of 60 stones each upon 8 acres; and allowing an increase of 12 stones each, equal to $13\frac{1}{2}$ stones per acre; will, at 7*s.* per stone, leave a return of 4*l.* 14*s.* 6*d.* in beef, to which add the value of mutton and wool made during autumn and winter, from 2 sheep per acre at 12*s.* 9*d.* each; total 6*l.* per acre, which estimate would, upon a yearly general average, be considered high. An acre of the best grazing land will produce then $13\frac{1}{2}$ stones of beef, and $1\frac{1}{2}$ stone of mutton, and 5 lbs. of wool, of the total value of 6*l.* per acre. If the same acre of land is converted into tillage, it will produce 12 tons of potatoes or 5 qrs. of wheat every alternate year through a course of 21 years, so that it is as 12 tons of potatoes, or 5 qrs. of wheat to 15 stones of meat and 5 lbs. of wool per acre; and similar results in point of produce would arise from all the inferior grass-lands being broken up. This part of the subject claims the most serious and careful consideration. The quantity of arable land in the United Kingdom amounts to 46,522,970 acres, and of grass 15,000,000 acres. It can be most satisfactorily proved that grass land, under arable culture, will produce twice as much food for man, besides finding him a vast amount of profitable employment; and, therefore, it becomes a question of the highest national importance. Nearly all the grass-lands are broken up in the most thickly peopled countries; in China, in Belgium, and others, with the happiest effects. The growing wants of this country demand that every facility ought to be given to promote this astonishing improvement in its agriculture; the population, increasing as it does at the rate of 1000 per day, must be provided for—*it must be fed,* and the most strenuous efforts are required, *and must be made,* to supply the daily consumption, and that at as cheap a rate as possible. This supply resting mainly with the landowner or his tenant, it is of some consequence to show that the interest of the one and the profit of the other will be best promoted by the conversion of grass-lands into tillage—this has already been done and needs no repetition, but for the great difficulty in convincing the farmer that it is to his interest to manage so as to continually improve his land, and in this way benefit the landlord as well as himself; and it is only in this way that he can do it, and that the landlords in general would be induced to allow their grass-lands to be broken up. The farmer *must* adopt and practise *high farming*—he *must* lay out much capital in cultivation, manure, and drainage; his profit depends upon this—the soil *must* be replenished and kept up to the mark; culture will do much, but manure will do more, and neither will be decidedly effective without good drainage. The poorest soils will give the largest proportional returns for

these particular items of expenditure. This course is a progressive one; land will improve under good culture, and ultimate benefit *must result*. Manures suited to every kind of land are to be obtained, and when it is once brought into a productive state it will, in a great measure, be self-supporting, by growing a sufficiency of herbage, under a proper rotation, to supply the requisite manuring; and, depend upon it, this supply of manure will contribute beyond any other to the farmer's profit; it is his "sheet-anchor," his "main-stay;" it supplies the very essence required by the crop, and both land and crop would soon be valueless without it—"muck (says the old adage) is the mother of money." If these principles were carried out with respect to a large portion of the 15,000,000 of acres still under grass, what an amazing amount of food may yet be produced from the soil of these kingdoms without impoverishment; and in describing the mode of breaking up and tilling each kind of grass-land, the object will be to point out such courses as shall, by judicious management, fully carry them out, so that in every respect it shall "*be better for the labourer, the farmer, the landlord, and the public*."

The mode proposed for breaking up and tilling each kind of grass land:—First, down lands, wold lands, or heath lands, These lands being thus designated in different localities are taken together, and may be further classed under these variations:—Sandy downs, light gravelly soils, thin clay, strong heavy clays, moor land and heath land. These are all met with in high open ridges, or in widely extended and elevated situations, and from their thinness of soil and varied quality demand especial attention. It is highly important that the small amount of fertility they naturally possess should not be impaired by being improperly broken up. The very common and almost universal mode of paring and burning should, if possible, be dispensed with. If however the grub, wire-worm, or larvæ of other insects abound, it must be adopted, taking care to avoid any unnecessary waste of soil. These lands are in general very inferior under grass, but profitable under arable culture with a proper rotation of cropping.

In describing the mode of breaking up and tilling light land, it will be desirable to class the *sandy downs, chalky downs*, the light loams and gravel, and the flinty chalks together, as the *general culture* is of the same kind on each variety of soil. All these varieties are well adapted to the alternate system of husbandry; would be far more profitable under such course; easily cultivated, and therefore ought not to remain under pasture. In breaking up the sandy and chalky downs of Wilts, Hants, and Dorset, the following mode is adopted, and has been found to

answer better than any yet discovered. It is thus described by an intelligent friend of the writer, and as it also clearly states the practice of paring and burning, it will not again be detailed. He says:—Pare the sward as thin as possible with the breast-plough, burn in small heaps at equal distances on the land, care being taken that the turf is not too dry, the ashes being much richer when it moulders away than if burnt quickly. When the ashes are well spread the land is *shallow raftered,* and then cut with a breast-plough the part left untouched by the rafter, at about one inch and a half in depth. The land is then dressed, and remains until the autumn, when the wheat is sown broad-cast, and dressed in. By this plan the wheat has a firm bed to receive the roots, and *wire-worm* seldom appears, nor is there any loss of plant. The second year turnips are sown, which are fed on the same, with hay or chaff, sometimes a mixture of both. It is again sown the following spring with rape, and eaten off with the sheep in *August* or *September,* and sown to wheat, care being taken not in any instance to plough more than two and a half to three inches deep, which is important to the success of the plan adopted, keeping the ashes near the surface, as also bringing the soil gradually to be acted upon by the atmosphere. Grass seeds or clover are sown in the following spring, dressed in and rolled off, which produces a large crop of sheep-feed, it is laid two years, but on the very high lands in some cases remaining three or four years, if the sward continues sufficiently productive, or sometimes oats are taken after the second crop of wheat, and then seeded down." Another course which is adopted is, to take rape or turnips after the paring and burning; 2nd, wheat; 3rd, oats; and then seeds. Many of these downs, in their present state, being of little value, would, when broken up, be much improved by a liberal supply "of bones, guano, or other enriching manure, thus laying the foundation for good corn crops to follow." Deep ploughing lands of this texture, when recently broken up, is found to be highly detrimental, as causing in severe frost a serious loss of plant; and has also proved an encouragement to the grub and wire-worm. A firm standing, it is universally acknowledged, is required for the healthy development and maturity of the wheat plant. "The paring, burning, and spreading the ashes varying according to the land, will cost upon the average from 20*s.* to 25*s.* per acre. Two horses will rafter* five roods per day, and the after-cutting 5*s.* per acre." On lands of this character in Norfolk, the higher parts of Lincolnshire, Yorkshire,

* To rafter or plough-rafter the land, as it is termed, is to plough only one-half of the land, turning the furrow ploughed upon the same breadth of land remaining unploughed throughout the field.

and the northern counties, the usual four-field, or four-course and shift, has long prevailed, *i. e.* fallows well worked, manured with fold-yard dung, and sown to turnips with bones, and chiefly on ridges twenty-five to twenty-seven inches apart, to be fed off. Second year, barley; third, grass seeds, or clover, in alternate courses; fourth, wheat. By this plan the clover is only sown every eighth year; the grass seeds to be fed off, the clover mown for hay. This rotation will ensure both cleanliness and fertility. In many districts the grass seeds are allowed to stand two years; latterly many of these soils have been sown to wheat after turnips, which have been either fed or carted off in November. After the wheat, clover, followed by wheat again, or grass seeds instead of the clover in the alternate course, followed by wheat. Beans or peas are occasionally taken after the seeds or the clover, and then wheat; tares or sanfoin may also intervene. These and many other deviations from long accustomed practice have been found to answer. The great thing is to keep within due bounds, so as to prevent exhaustion of the soil on the one hand, or too close an approximation of the same or similar crops on the other; and every intelligent farmer is, or ought to be, a competent judge of these matters. A slavish adherence to any one course of cropping or procedure in culture or manuring, being a limitation of skill and enterprise, is not judicious. Extra culture or management ought and will produce extra benefit, so that, with common attention and care, the better the culture the more numerous and profitable the crops. In the cultivation of these soils attention ought to be more directed to the use of proper implements; from their light texture it cannot be at all times requisite to use the plough. The writer has seen the old Kentish turn-wrest, drawn by four horses, at work in skeleton or broad-share ploughing very light land. This must be unnecessary; a small skeleton-plough, drawn by one horse, would be nearly as effective, and would on these soils be amply sufficient, with light scarifying, to prepare them for beans or peas, which, being taprooted plants, will find plenty of nutritive food without deep ploughing; and as the seeds and roots of weeds are thus kept on the surface, it facilitates the growth of the seeds, and the picking off the roots. The U. L. plough, manufactured by the Messrs. Ransome, is admirably adapted for this purpose, and for the many other uses connected with trench-ploughing, or row and ridge culture. The skeleton-plough would on such lands be very effective as a preparation for wheat. By its means a thorough pulverization may be obtained without disturbing the subsoil, and thus leave for the wheat-plant a firm bottom, which is so essential to its yield and quality.

In the application of manure to these soils great care ought to be observed. The dressings should be frequent, and on no

account heavy, because much loss would ensue from the porosity of the soil; besides heavy dressings of fold-yard dung would tend to keep the soil open, and cause loss from drought, &c. The chief application ought to be given to the turnip crop, it being the foundation upon which the subsequent ones have mainly to depend. The ridge system of turnip-culture is far preferable for retaining the full value of the manures deposited. They should be covered in and *thoroughly rolled down* within *the hour* of forming, and drilled *the same day*.*

Bones have become almost indispensable to the good cultivation of these thin soils, and the small quantity of six bushels per acre, drilled on twenty-five inch ridges, will have great effect on the turnip crop. The modern discovery of dissolving them in (or even by) sulphuric acid is of great advantage, both in economy and usefulness. Bone manure is not of much benefit to any soil unless it is well drained and made free and open in its texture.

Rape-dust or cake would be of great value in a cool, moist season, but is on that account uncertain in result. On cold or wet situations it would answer well.

The consistency of these soils is surprisingly improved, and their fertility highly enhanced, by the application of clay, marl, chalk, or any heavy earthy matter.

In every application of fold-yard dung care must be observed so as to retain every volatile particle for the soil. The time of application must be well chosen; if for wheat, immediately before ploughing; for spring crops the same; for clovers or the grass seeds, the early part of the winter, as the snows and rains will wash down the constituent parts into the soil, besides protecting in other respects the plants. It must never be applied except to be ploughed in in the summer, as is commonly practised, because the sun and the heat will destroy its valuable properties.

Clays, or Clay Soils.

Loamy Clays, Cold, Heavy, and Thin Clays—Loamy Clays.—These lands frequently produce a sweet nutritive herbage, and where the pasture is required for dairy farming, or the rearing of young stock, might be kept under grass. It is, however, very questionable if this course is the most profitable. Young beasts and dairy cows may be equally grazed upon the cultivated grasses of mixed variety. The broad red clover, or the white Dutch, may be too luxuriant, or too strong, or too acrid; but this may be

* If the manuring is heavy, the ridges will require rolling again in about a month; they require compressing as the manure decays. The turnip plants will not be materially injured.

readily corrected by the other grasses. Rye grasses, Timothy grass, and rib grasses are hardy and of quick growth. Field parsley and chiccory would be very healthy additions, or white mustard again; besides, the various pasture grasses producing seed of hardy growth might be introduced, so as to prevent any ill effect to either cattle or sheep. Such being the case, and as by these means a far greater amount of produce is obtained, more cattle and sheep are fed, and, as before noticed, the corn crops are obtained in addition to these. It does then appear that they might without inconvenience, and certainly with greater profit, be broken up.

The mode to be preferred is the same as in the preceding case —and in nine cases out of ten is applicable to every soil—by paring and burning. This should be commenced in the month of June, and immediately after the ashes are spread, to be ploughed in, to prevent injury by exposure, and the land sown with rape or turnips. This course will enrich the soil, and also prevent damage, by the destruction of immense numbers of grubs and wire-worm, as also the chrysalis, larvæ, and eggs of others.

The course of cropping may be liberal. First rotation: Oats, wheat, beans, wheat, peas, wheat. Second ditto: Fallows, well manured, and sown with turnips, oats, wheat, beans, manured wheat, clover, wheat drilled in with rape cake. By this rotation its condition will be kept up; but it would be further aided by occasionally taking barley after the fallows, next clover, then wheat, beans, or peas, wheat; manuring the land for the pulse crop. Potatoes might at long intervals succeed the barley crop. As to its general management, it is sufficient to say that it is all important that it be thoroughly drained, and well worked, broken, or pulverized, at every returning season for putting in the crop. Every kind of manure may be applied with great advantage under ordinary care and judgment, and no kind of land will better repay the occupier for his outlay.

Cold Heavy and Cold Thin Clays.—As the management of these must be similar, they may, for the sake of brevity, be taken together. In breaking them up it will be necessary, on the thin clays, to pare and burn as thin as possible, while on the heavy soils it will be right to go deeper. The thin clays will not bear so heavy a rotation of cropping as the strong soils, and the application of dung should be more frequent and in lesser quantities: with slight deviations, however, they may be cultivated in the same manner as the cold heavy clays. Land of this strong tenacious character, when properly underdrained, will make very useful pasture, or good arable lands, and neither without it. This is absolutely necessary to every soil of any degree of tenacity. The

strong and most tenacious class may be effectively drained by the mole-plough, worked by a capstan, at a small cost per acre; but every variety of soil would be better and more permanently drained by tiles, pipes, or stone drainage; and, if the outfall is good, any reasonable depth may be obtained. Lands drained at wide intervals, and at the depth of five feet, will be more efficient than at lesser intervals and a shallower depth. The water will always find its way wherever the sun and drought of summer, or the frosts of winter, have opened the soil. The difficulties experienced by clay-cultivators have been surprisingly diminished by good subsoil drainage; and it has had the effect of rendering such soils far more profitable under arable culture. Under pasture they are very uncertain, from their great liability to injury from drought in summer, or water in winter or wet seasons. In both cases the finer grasses are destroyed, and when wet the land receives injury from the treading of stock. Under culture the superior quality and weight of grain yielded will amply compensate for any little difficulty that may arise. There cannot be a more appropriate method of breaking up heavy clay-land than paring and burning, and that at a good and sufficient depth. No land is so infested with grubs, or larvæ in general, and the number thus destroyed is astonishing; besides, the quantity of ashes obtained, to be spread and ploughed in, or carried on to other old lands, renders the soil open and porous, and is the great means of securing future crops. This operation to be executed in June, or early in July, as already stated. Rape should be first taken, followed by beans or oats; third, wheat; fourth, beans, in rows, to be horse-hoed during the whole summer; fifth, wheat, to be drilled in with 7 cwt. of rape-cake dust. Second course: Fallows; to be well dunged and sown to rape; second, oats; third, wheat; fourth, beans, or clover, or tares, alternately, as the course comes round; fifth, wheat. A moderate dressing of dung should be applied for the bean crop, or, if clover, laid on in the winter; when the clover comes up for wheat it should be ploughed early, and well rolled down: the bean-land should undergo a thorough tilth before ploughing for wheat. This course of cropping it will sustain, under ordinary management, without injury. The thin clays would require beans after the oats or clover, and then wheat. A field of clay soil, containing 20 acres, in the occupation of the writer's brother, was thus broken up in the past summer, and the crop of rape, or coleseed, as it is provincially termed, he has sold under agistment to bring him in 5*l.* 12*s.* per acre: many of the plants are 4 feet in height, and of proportionate bulk. Three years since he broke up on the same farm two fields of like character, in the old and too common method, by merely ploughing and

sowing to oats: he has lost both the years' crops by wire-worm and grubs. He states that, in the operation of paring and burning in the past summer, thousands upon thousands of these little voracious creatures were destroyed. Every mode calculated to promote thorough pulverization ought to be adopted on these heavy soils. Subsoil-ploughing would be very efficacious, and should be repeated at intervals of about five years, till the land is rendered open and friable: be it remembered, however, that it is of no avail without previous subsoil drainage; deep ploughing and other deep working may then be accomplished without difficulty. This, aided by a liberal application of lime, chalk, or fish-shells, will soon render it mild and convertible. Lime ought to be applied as follows:—At convenient intervals during the winter, lead into heaps, to be laid on a dry spot, as much as may be required for use, of the best well-burnt lime to be met with; the larger the heap the better, taking care that neither air nor rain shall slake the heap before completed, which ought to be done as quickly as possible. The first smart rain will slake sufficient to form a crust over it, to keep out the weather, and also prevent its falling too fast. No lime must be added to the heap, however small it may be, after rain sufficient to wet it to any depth, as it will cause both to fall and render them unfit for use. When all is collected, and well rounded up, the air or rain will soon make it secure. When the fallows are sufficiently worked and prepared for sowing, open the heaps and *lead on in dry weather*: spread out of the carts at the rate of about from three to five chaldrons per acre, and in this way it will be applied in its most caustic state, when, if well harrowed and worked in, it will promote the decomposition of the vegetable matter in the soil faster than by any other mode yet discovered.

The application of chalk should be in the autumn and early part of the winter, and laid upon the land, to be fallowed at the rate of about 500 or 600 bushels per acre, being about 25 or 30 cart-loads per acre, and evenly spread. The air and winter's frost will cause most of it to fall, so as to be with great benefit incorporated with the soil, and the summer following will do much to reduce the remaining.

Fish-shells, such as mussels, do great good applied fresh from the shore on fallows, or they may be carried to the fold-yard and mixed with the manure.

Of all the various applications of manure tried, none has been found to equal fold-yard dung, when well and richly made, by the consumption of large quantities of cake or green food.

It should if possible be kept in the yard till required for use, only turning it once to promote equal fermentation, about five

weeks before leading on the land. It is lamentable to witness the waste occasioned very often by its foolish exposure in making compost heaps and the like. It cannot be kept too close till required, and on clay soils a liberal supply will be retained; but on all light soils smaller and frequent dressings are preferable.

Peat, Moor-land, Bogs, Mosses, Heaths, &c.

Peat.—These lands, possessing a surprisingly rich soil of great depth, are altogether unprofitable under pasture, because the best natural grasses do not readily grow upon them; and, being under proper cultivation, the most productive of all soils, it can scarcely be necessary to remark that all should be converted into tillage. This must be by paring and burning, as before, being cautious lest it burn too deep. Sow rape for feed; second, oats; third, wheat—the wheat stubbles to be well clayed; then fourth, beans; fifth, wheat. Second course:—Well fallowed for potatoes, being liberally dunged; second, wheat; third, beans; fourth, wheat, or alternately, instead of the bean crop; *clover* or *grass seeds,* followed by wheat: the seeds to be fed off: the clover mown for fodder.

General Tillage.—Draining, of course, must be the first improvement, and both surface and hollow-draining are now practised: the latter is effected in a very simple way, and with good effect. The "dead peat," commonly called "bear's muck," is so hard that when cut into shape, and laid across a well-formed narrow-bottom drain, it will soon swell by moisture so large as to form a good hollow drain below it. The dried "*peat* bats," or brick-shaped turf, used for fuel, will also do well. This subsoil draining has the twofold advantage of consolidating the peat, and absorbing the superfluous moisture. Almost upon a par with draining stands the modern improvement of claying. It not only prevents a too rapid evaporation in summer, by giving solidity to the peat, but it also gives a tenacity to it; in fact the admixture is such as to form a new soil, composed of clay and vegetable matter, of surpassing value, producing every kind of grain, of great weight and excellent quality.

The usual practice is to commence in the autumn, and continue during winter, if possible, to dig the trenches along the whole length of the field. They should be about 4 feet wide, and 8 or 10 yards apart. Sufficient clay must be thrown out, so as to cover the whole surface about two inches in depth, when reduced and spread minutely; it is however more generally left in half-spit lumps to the action of the frosts or atmosphere.

In fallowing, the roller is in constant use, as also drags and harrows, ploughing not being so needed. It is no uncommon

thing to obtain from 500 to 700 bushels of potatoes per acre; and in favourable seasons the yield of grain is excessive. A friend of the writer, farming on the edge of *Wittlesea Mere*, had from this cause, and exceedingly good management, in the year 1844, a yield of 48 bushels of wheat per acre upon a breadth of 160 acres.

Moor-land, Bogs, Mosses, and Heaths.—The moors of the mountains possess such humidity, are so bleak and cold, and so inconvenient to approach, as altogether to unfit them for arable culture. Those on the hills at a moderate and approachable height might be drained and brought into cultivation, and would yield good crops of spring corn and green food for cattle. The soil possesses much inherent value. Soils composed for the most part of decayed vegetation are the most productive of all when properly cultivated.

Bogs and Mosses.—These must be thoroughly drained by surface-drainage till rendered compact enough for subsoil-drainage, which must then be at once adopted: superabundant moisture is its great bane. If this can be drawn from beneath, the whole becomes compressed, and is rendered available for general cropping, to which it ought undoubtedly to be appropriated, and would yield abundant supplies of vegetables in the first crops, and would speedily be brought into a fit state for general cropping. Much yet remains to be done in this respect. The bogs, moors, and mosses of this country are numerous, some extensive; but, compared with the Sister Island, unimportant. Assuredly the most comprehensive and effective steps ought immediately to be taken to reclaim the whole. It ought to be taken up nationally, as one great means for the employment of surplus labour and providing food for the public.

"*The Great Level of the Fens,*" comprising upwards of 600,000 acres, four-fifths of which is under arable culture, would average from the harvest of 1844 from 40 to 50 bushels of wheat per acre, of excellent quality and great weight. What other district can equal this? What was it at the commencement of the present century, only 46 years ago?—a swampy morass, partially drained, now a dry, healthy, and most fertile plain, probably the most productive in the world.

Heaths and Wastes.—These lands may be with good judgment made profitable under culture. The long heath, coarse herbage, fern, &c., should be grubbed up, and the surface pared and burned as before. These soils, being so thin, require much aid by top-dressings of clay, marl, lime, or other material, as judgment may dictate, according to the local circumstances, and the general culture, as already detailed, for such soils.

Good Meadow, or Grazing Grounds.

Having already made some remarks upon land of first-rate quality, it will be only necessary now to notice the general average of such soils. Good grass lands will make superior arable lands; and will yield, as previously shown, a far greater produce. This ought of itself to be a sufficient reason for converting them into tillage; and it may be done, and the cultivation carried on under a careful system of good husbandry, without being detrimental to the soil. Indeed it would be gross folly to impair its powers of production, and which the landlord would do well to guard against.

The most certain and profitable mode of breaking up these lands is to take one or more crops of brown mustard, according to the strength of the land. The usual mode of preparation for this crop is to commence early in the month of March, by ploughing the land at a moderate depth. It should lie three or four weeks, to allow time for the sward to decay and consolidate, or close with the furrow-sole. When sufficiently decayed, about one-fourth of a peck of seed should be sown per acre, and harrowed in as lightly as possible, so that the seed be covered; all loose sods to be gathered into the furrows. It will require hoeing in the month of May, and should be left rather thin in plants, supposing them to be healthy and vigorous. No further attention will be required until ready for cutting, which will be in the early part of harvest. It is wrong to disturb the plant; turnips thrive all the faster for being stirred, but it is not so with mustard; its long taper root is best left alone. When ripening, the pods turn to a deep brown (almost purple) colour, and just as they, the pods lowest on each stem, are turning to a lighter brown, the crop should be cut: the succulence remaining in the plant will fully ripen the seed. The great aim with all growers is to preserve the seed of a bright reddish-brown colour, as all the profit depends upon this being done. Light coloured, or grey seed, will only fetch about half the price of that of perfect colour. It is the anxious aim of the grower to have it "in pie," or stack, without rain. If cut green it may be tied into sheaves, and set up to dry; but the common practice (and perhaps the best, as it loses much seed if blown down) is to lay it in separate reaps along the stubble. The land should then be cleaned, skeleton-ploughed, and harrowed, and the dropped seeds made to grow. After the mustard a crop of potatoes might in many cases be taken, followed by wheat. Potato culture is so well known that it is only necessary to observe that the land should be winter-ploughed, and left so till near planting time, then cross-ploughed, well worked,

and planted with some unexhausting variety. Beans, well manured, and in rows, should follow the wheat, to be succeeded by wheat again, and then fallowed and sown, first with turnips, or rape; second, oats; third, clover; fourth, wheat; fifth, beans, manured; sixth, wheat. Third course:—First, turnips, after a good fallow, well manured; second, wheat; third, beans, in rows, to be horse-hoed; fourth, wheat. Fourth course:—Turnips, oats or barley, clover, wheat, beans, wheat. Twelve tons of manure must be applied to the turnip crop, and six tons to the bean crop, per acre; and with this liberal supply of manure, and this system of alternate cropping, these soils will be kept in good heart and condition, thus producing a greater amount of food; and being kept in such a state as to yield a higher rental to the landlord, will ultimately cause the equalization in price of both *arable and pasture lands.*

XXXII.—*On Cheapness of Draining.* By Ph. Pusey, M.P.

Having given in this Journal low estimates of the amount to which it seemed to me practicable to reduce the price of draining-tiles and of cutting the drains, I am now enabled to substantiate those estimates by what is much more satisfactory—actual cost. The field I shall instance is of 18 acres, consisting chiefly of strong clay, was drained a year since, and the cost has been only 30*l.*, or about 1*l.* 13*s.* per acre. The work was done with inch-pipes, laid at a depth of 34 inches, and, on examining them yesterday, I found a steady stream flowing from the mouth of each pipe, notwithstanding the stiffness of the clay in which they are buried. As estimates of 8*l.* per acre are still to be met with, and as it is sometimes said that 3*l.* are the least sum for which an acre of land can be drained, although I have no discovery to make known, the simple facts of the case may not be useless.

The inch-pipes cost me 10*s.* only per 1000. By cost I do not mean any estimate of the expense at which I had made them: such estimates are often deceptive. Ten shillings were the price paid for them to a tradesman, including, therefore, his profit. I know that 16*s.* and 18*s.* are even now charged for such pipes in many parts of England; but as this extra price is a heavy tax upon draining, I wish to convince the tile-makers themselves that it is for their own interest to reduce it. There are no peculiar advantages in this neighbourhood to account for our lower price. Coals, indeed, are rather high, costing 20*s.* per ton. The whole

secret consists in preferring a large business with small profits to high profits on a slow and insignificant trade. This tile-maker, having purchased Clayton's machine, offered, by my advice, pipes for sale at a graduated scale, namely 12*s.* per 1000 for any quantity under 50,000; 11*s.* under, and 10*s.* above 100,000. The consequence was that he obtained at once last year very large orders, and this year, having extended his business, has received an order from one individual for 600,000 pipes. It is remarkable that on the very farm of which I have spoken the price of 100*s.* per 1000 was paid for tiles, besides the soles, fourteen years since.

Having obtained these cheap pipes, it remained to put them cheaply into the land. Here, instead of anything new, I have only to describe the oldest practice of English draining, which is known and proved to be a hundred years old; and I must remark that, though thorough-draining is spoken of as something new, and is new in the north of England and Scotland and Ireland, it is anything but new in our eastern and southern counties, where it is as familiar to farmers, and as easily performed by labourers, as ploughing or threshing. My drains, then, were cut out in our old method of cutting them for thorn-draining, that is, by taking out one spit with three bouts of a common plough, another spit with a narrow spade, and the third spit an extremely narrow slit, into which the inch-pipe fits exactly. The lumps of clay are thrown back, being rammed loosely down, but not pressing upon the tile; and the wages of the men for this work is 3*d.* per pole.

Having recommended from experience the Essex lance-headed tool for making the bottom slit, I may mention that in this particular field the labourers having accidentally begun to work with our narrow Berkshire tool, found that they could not earn proper wages under 4*d.* per pole, nor hardly at that price; but as soon as they received a supply of Essex tools they were well satisfied with 3*d.*, agreeing that, after this change, one man could do the work of two, and with greater ease. This tool, however, is only fit for clay subsoils which are free from large stones.

Having fixed these two points, the price of pipes and the price of laying them in, we of course arrive easily at the cost of draining an acre. The statute acre is 660 feet, or 40 poles, or one furlong in length, by 22 yards in width. A single furlong of drains will cost 6*s.* 8*d.* for pipes and 10*s.* for workmanship; altogether 16*s.* 8*d.* Two drains in width will generally, I think, be sufficient, making 33*s.* 4*d.* per acre, with a trifling addition for master-drains.

It may be objected that the depth of 34 inches is an insufficient one. Now, without at all denying the value of deep-draining in porous soils, I confess that in a really strong soapy

clay I should be afraid of cutting my drains deeper than 3 feet. There is moreover another point to be considered. Such land is frequently laid up in ridge and furrow at different widths, two or three feet high in the centre. The stronger the loam, the narrower did our forefathers form their lands, and thus the ever-circling plough, which in the course of ages has brought the solid mould to the resemblance of a rolling sea after wind, has imprinted on the very surface of our fields the varying character of the soil beneath. Thus too you may often adopt the ancient furrow as the fittest interval and the most convenient course for the modern drain; and the consequence will be, that when it is no longer needed for carrying off the surface water, you may gradually plough down these high ridges, and so increase safely the depth of the drains by raising the surface above them.

Having then proved my former estimates as to the cheapness with which under-draining may be effected upon the strong clays, I will now go a step further, and attempt to show that in many cases under-draining may be dispensed with altogether. I mean on level boggy land, with a gravelly subsoil: and I am the more desirous to bring forward the facts on which this opinion is founded, because now that Ireland is to be so largely improved there is great danger of a wasteful expenditure in draining the Irish bogs if the necessity for *under*-draining them be overrated; and I will first mention some mistakes of my own.

Many years since, adopting, with the zeal of a novice, the theory of thorough-draining, believing in its novelty, and therefore slighting the experience of farmers, I under-drained 30 acres of bog-land, at an expense of 10*l.* an acre, notwithstanding the opinion of my neighbours that the drains were far too numerous: several other bogs were also under-drained by me at the same time. But one green moor of 40 acres, parts of which were hardly passable, was accidentally postponed on account of a doubt as to the plan. In the meanwhile, observing that on some of the moors which had been intersected by deep ditches the drains only ran after violent rain, and that for a very short time, I determined on attempting to drain this particular moor without any under-drains. Having secured a good outfall for other purposes, I dug a ditch, 5 feet deep, round 24 acres of this field. The water sprang from the gravelly bottom, and has continued to run ever since, winter and summer, in a brisk little stream; and the inclosed space of 24 acres became at once thoroughly sound. The expense of cutting the ditch was but 20*l.*, or less than 1*l.* an acre. Its efficacy certainly strengthens Mr. Parkes's principle of cutting drains deep on suitable soils. Another moor, which I have just surrounded with a deep ditch, seems to me to be equally sound. In reclaiming *level* marshes, therefore, with a porous subsoil, I

should advise, in the first instance, to try the effect of *dividing them first with deep ditches in blocks of* 10 *or* 20 *acres.* These ditches will serve as boundaries, and the material that comes out of them helps to consolidate the surface of the field, which is often light. If these blocks of land standing 5 feet above the water-level should still be wet, it is easy to put in two or three under-drains afterwards: but I hope that my own precipitation may warn others not to waste their money as I have done in *under*-draining such land. This method is in fact the practice of our great fen district, which is the best and largest example of such improvements, as Essex is of clay-draining. In the Fens, I believe that these boundary ditches are found to give ample drainage. In summer indeed they are often allowed to stand full of water, and thus keep the land cool. Every one who is practically acquainted with moory land knows that such land may be easily over-drained, so that the soil becomes dusty, or *husky*, as it is called—that is, like a dry sponge—the white crops flag, and the turnip-leaves turn yellow in a long drought.

On strong clays, therefore, I would recommend the English form of under-drain, as cut of old in our southern counties, with the more modern pipe laid in its bottom: and if any one be afraid of the inch-pipe, he may increase its bore with a very slight increase of expense.

On level swamps, with a porous subsoil, I should decidedly try deep boundary-ditches first; and, in support of that view, will conclude by a quotation from an excellent account of Sir James Graham's improvements at Netherby, published by the Society for promoting Useful Knowledge as long ago as the year 1830. The evidence is the stronger because that was the first estate, I believe, on which cheap tiles were produced, and because even at that date under-drains were cut as deep as from $4\frac{1}{2}$ to 5 feet:—

"But previous to so expensive an improvement as underground draining of any description being set about, let every agriculturist, whether landlord or tenant, examine carefully the state of the ditches round his field, and he probably will find, in nine cases out of ten" (this proportion appears to me rather too high), "that the real evil consists in their insufficient condition, arising from their want of depth and want of scouring. Let them be all deepened to $4\frac{1}{2}$ feet in depth, and wait a season, and he will probably save a large outlay, that would have been expended to little or no purpose......It is proved from that which takes place in the greater part of England, that very large and serious outlays take place in underground drains which the more simple, the more obvious, and the least expensive improvement of deepen-

ing and scouring the boundary-ditches would fully and effectually accomplish."

Pusey, Jan. 30, 1847.

Postscript.—Since these remarks were written, I have obtained from Sir James Graham himself an entire confirmation of them. He informs me that more than once, after cutting a ditch six feet deep for some distance through a level swamp, for the purpose of under-draining, he has found under-drains unnecessary, the ditches alone drying the land to an extent of 40 or 50 acres; and after 25 years' large experience of draining he made the same remark which I have already made, but am glad to confirm by his authority, that in dealing with level porous soils you should never put in an underdrain until you have tried the effect of deep boundary ditches. My own experience has shown me many instances of their efficacy. In one case I unintentionally drained 50 acres of strong loam resting on stone-brash, by cutting a deep ditch on one side of it only in the underlying rock. Twice in digging ditches through swamps I have laid wells dry, one of them a quarter of a mile distant, which my neighbour in consequence was compelled to deepen.—Ph. Pusey.

XXXIII.—*Some Account of Spring Park Farm.* By Hewitt Davis.

To Mr. Pusey.

Dear Sir,—I am honoured by your request that I should furnish for the 'Royal Agricultural Journal' some account of the practice I have adopted in my farming. I think I may do this with more advantage if I preface it with some account of myself as a farmer, notwithstanding the charge of self-sufficiency which might thence arise. Yet I cannot better induce confidence than by showing that my plans have not been adopted from early habit, but rather been selected by reasoning from the best examples. I undertake the task to be of benefit to others, and trust my humble efforts will be accepted in the spirit in which they are made.

It may be well for me at the outset to state, that I was twenty-one before I thought of becoming a farmer; for I feel it has ever been of advantage to me that my farming education did not commence so young as to inoculate me with any particular practice, but rather began when I was of an age to seek information, and open to every consideration that might conduce to a more

profitable cultivation and return. Previous to that period I had been engaged in mercantile employment, where every question was tested by figures, and I had learnt the necessity for keeping very accurate accounts. This training has been most serviceable to me. By my accounts I have frequently been set right on many a question with which I could not otherwise have grappled, and by them have gained confidence to enter into expensive improvements. My farming commenced by my being put in charge of 2000 acres of highly-cultivated land. Here, with the assistance of bailiffs, I began by keeping the accounts by double-entry; and while I was gaining practical information by daily watching what was doing on the farms, I was carefully perusing every work on agriculture that was recommended to me. The advantage that all this has been to me leads me to think the common education of the sons of farmers is sadly defective for any business, and more particularly for their own. When we reflect how much their practice should be dependent on calculation of cost and returns, and how greatly they may be benefited by understanding principles of vegetation, and by an acquaintance with chemistry, botany, geology, mechanics, and science generally, it is lamentable to see how little progress in education has been made by farmers' sons at the time of their removal from school: they are generally taken away before they are sufficiently advanced to have gained a taste for study, and, indeed, frequently before even reading and writing have ceased to be a labour; and hence it is, that as a body, farmers, although enjoying much more leisure than falls to the lot of other classes, have less taste for reading or acquiring information. Then, again, their habit of bringing home their sons to learn their business, must necessarily present a further obstacle to the advancement of agriculture: the narrow practice thus presented to the view of the son is hampered by all the prejudices of the father; and in this way is improvement shut out, and the barbarous husbandry of an early age made to descend from generation to generation.

But to return; at the age of twenty-eight years, when by study and the opportunity I had had of seeing the practice of others, I thought myself competent, I took, at a rent far beyond the value, Spring Park, a farm of 500 acres, principally a boggy, gravelly soil, which at that time scarcely returned six times the seed put on it. I believe the state in which I found this farm would have broken the heart of an older or more experienced farmer; but I had entered upon it with buoyant spirits, and was young, and not of a character to despond; nor did I then foresee the time, labour, and outlay necessary to make such a soil profitable, and I fortunately was assisted by an income from other sources, which kept increasing, and found me means through a

long period of heavy expenditure and ungrateful return. I continued to work my farm under every disappointment, with that energy and perseverance which ensure success; and I can venture to assert that the crops at Spring Park have latterly equalled those on very much better land, although raised at less cost, and that my wheat is now grown and sent to market, exclusive of all profit, under 36*s.* per quarter.* Before my occupation, the Spring Park farm had been lying waste for seven months, and was at my entry in as bad condition from its poverty, the unchecked growth of weeds, and the almost total absence of material to keep stock and make dressing, as can be well imagined. Besides giving the usual routine of ploughings, dressings, and cleanings, my first important attempt to improve the land was to trench it deeply. This I accomplished with a monster turn-rice plough made for the purpose, and to which I attached eight powerful horses. With this implement, and the assistance of two men following with pickaxes to work up the larger masses of rock, we accomplished about half an acre a day; thus continually crushing and bringing to the surface in blocks, the iron-bound gravelly bed that pervaded the soil 6 or 7 inches below the surface. By this means I deepened the land, and the quantity of soil available to plants became more than doubled; the corn is now enabled to stand the summer drought, while the labour of tilling is for ever diminished. This novel mode of proceeding caused considerable astonishment, and my neighbours generally considered I was doing harm, for they thought the little soil there was on the surface I was for ever burying; that is to say, I was putting the good soil out of reach of plants and poisoning the surface by turning up a hungry gravel from beneath.

Perhaps I may as well here speak of the difference between trench and subsoil ploughing: the former is intended to convey the idea of bringing to the top the subsoil from beneath; the latter, of merely breaking the under pan. I should not do right were I to omit to state my conviction, that whilst the benefit from the latter is considerable, the utility of trenching is far greater. I am aware an opinion is very prevalent, that many subsoils require sub-pulverizing before bringing to the top, and that placing raw earth on the surface may be injurious. I would assure my readers my experience has shown me this is a great mistake. I have

* The fact that wheat may be grown at a cost of 36*s.* per quarter, I think, independent of every assertion, is shown by the detailed estimates at the close of this paper. I readily admit that to bring inferior land into condition to do this a large capital, in the first instance, must be sunk; but tenants taking such farms should hold them on long leases at low rents; and then the difference between the rent paid and the rent the land is made to be worth by the improvements, will be the equivalent obtained for the outlay.

repeatedly whitened land by the quantities of chalk I have brought up, or have covered the surface with stones and clay from below, and have never found any mischief therefrom; but, on the contrary, the soil at once has been improved by the mixture. I had learnt from study, that all soils are composed principally of the oxygenized dust from metallic rocks, a change brought about by the atmosphere and the mechanical actions of the alternations of heat and cold, wet and dry. I had also seen the practice in fresh enclosures for cottage-gardens, where trenching is the first operation to make a waste fertile; and I had also witnessed that a neighbour, simply by turning over 2 feet deep a bed of gravel, had raised a quick-fence aside of land belonging to a rich neighbour, on which, with the aid of manure and added soil, quick had failed to grow. I therefore persevered in the plan I considered essential to give a produce, until I had turned over every acre of land several times, and gained a depth of 14 or 15 inches of soil, where originally I had found only 5 or 6. The next obstacle I had to contend with was want of drainage. I saw my sheep in winter wading up to their bellies in mud, and in the spring my season for tilling and sowing was ever delayed for weeks, and not unfrequently spoilt through the sodden state of the land; and my winter crops were starved or partially destroyed by the chilling effects that stagnant water ever produces. My attention was soon drawn to the difference of crops on parts of fields partially dry, and I began to calculate how great was the loss where the land had lain wet, and the fact was made apparent, that frequently *the entire expense of draining is to be gained back by the first year's improvement in the crops.* One great advantage from deep draining is the higher temperature of the soil gained in the spring, and the consequent more forward vegetation. I believe I have by this means given an earlier growth of some weeks; or in other words, taken from the winter's rest several weeks to give them to a summer's growth. I was fortunate, too, in being convinced at an early period of my farming, of the greater benefit from deep over shallow draining; and my landlord having agreed to provide me with tiles, I proceeded to invest 500*l.* in draining the wettest of my land. By this means I have succeeded in changing a very watery soil into a dry one—a backward vegetation into an early one. How much in this way my live stock have benefited, and my produce per acre increased, and the quality improved, it is difficult sufficiently to estimate. My land, at the time I took it, was much subdivided by ditches and borders, and shadowed by scattered trees. The evil from this I soon saw was very considerable; much loss of time in tillage occurred by the frequent turns thus occasioned; and I had early learnt that time was money: the weeds from the bor-

ders were continually spreading out into the fields, and the trees threw an injurious shade, and besides robbing the land were highly mischievous, and occasioned considerable loss. To remedy all this, I proceeded forthwith to fill in the ditches and grub the borders, taking care where necessary to first lay in the ditches capacious drains. In this way I must have largely added to the average yield of my land without bringing any addition to my rent or parish-rates, and with a positive reduction in all the expenses of cultivation. I have also derived considerable assistance by availing myself of the improved implements that have lately been introduced. By their assistance I have been enabled to do the work of the farm with considerably less labour than was necessary to my predecessors; and by wide drilling and the free use of the horse-hoes and Finlayson's harrow, I am enabled to keep my land clean without having recourse to fallowing, and thus not only avoid the great expense of fallows, but have every acre of my land always under crop, always producing. I had, moreover, seen the loss of manure that bad yards occasioned, and the importance of a greater economy not only in the collection, but also in its preservation. My attention had been early called to the improper arrangement of farm-buildings and ill formation of yards. By sacrificing two or three old sheds, and the construction of a new barn, with lean-tos for cattle to weather under, I brought my yards into squares, where the stock lie sheltered in the winter by the barns, sheds, and stables, that surround them; and by hollowing out the centres, and constantly applying material to absorb the liquid, the manure is collected and held with as little waste as possible. In this way (besides the better accommodation for the animals) I have more than doubled the home means for enriching the land.

Having alluded to the more important means by which I have been enabled to increase the returns from Spring Park, and from farms very variously situated and of very different characters, I must hesitate ere I further occupy space in the Journal by details of minor importance; and I know not how I can better close this sketch than by attaching the account of my farms and mode of culture as it appeared in the 'Maidstone Gazette' of the 11th of August last:—

'The principles on which Mr. Davis professes to farm are to be found in the following address to a farmer:—

'1. Never to be contented until all your land has been trenched and turned over by the plough a foot in depth, nor until

'2. The wet land be made dry by deep draining, and consider no land effectually drained unless the drains be 4 feet in depth; that is to say, unless the water-level be so far below the surface, that corn shall

have at least a foot of dry earth to root in, unaffected by capillary attraction of moisture from below, and the chill that water nearer to the surface causes; this can be done only by having the drains 4 feet from the surface, and within 40 feet of each other.

'3. For sowing of spring corn on dry lands, consider the season commences with the new year, and have no other fear than that of being too late. When the ground is dry enough and fine enough, the sooner it is in the better; it will yield more, and the liability to blight or to be beaten down will be less.

'4. In sowing, drill or dibble all, and have the rows not nigher than a foot between them, so as to admit of hoeing either by horse or hand, and hand-weeding at late periods.

'5. Hoe and hand-weed all corn; let not a weed in flower be seen amongst it; ever recollect that weeds occupy space and consume nutriment, displace corn, and rob the land.

'6. Never sow two crops of one genus in succession; legumes or pulse may follow cereal grain, and cereal grain may follow legumes or pulse; but never cereal after cereal, or pulse after pulse. Recollect rye-grass is a cereal plant, and unsuits the land for white straw corn.

'7. In apportioning the rate of seed per acre, do not lose sight of the bad consequences that must ensue if too much be sown. Bear in mind, that if so much be sown as to produce more plants at first than the space will afterwards allow to attain maturity, the latter growth of the whole will be impeded, and a diseased stage will commence as soon as the plants cover the ground, and continue till harvest.

'8. Manure should be applied only to green or cattle crops, and never to corn; by giving it to the former, the earth derives the advantage of the extra dressing that the extra growth returns; but when applied to corn, the earth is so much the more exhausted by the extra growth of straw, and frequently too the grain is thereby positively injured by being beaten down and blighted in the straw, it always is made more hazardous by dressing.

'9. Were farmers to buy all their manures, they would find that the cost of maintaining their land in fair heart would be about 1*l.* per acre per annum. This quantity of dressing, every farm in fair productive cultivation would supply of itself, if a proper use and economy be made of its material to form manure, and a due care taken of it afterwards; but from misapplication and waste of the straw and fodder, and from negligence in the preservation of the dung and urine, at least half is usually lost, and the arable land of England may thus be said to be prejudiced at least 10*s.* per acre.

'10. Were no other injury done to the crops by trees and hedges in small enclosures than that which arises from their mischievous shade and shelter, it would be equivalent to the ordinary rent of such fields; but the farmers sustain a further loss in the additional time occupied in its tillage by the more frequent stoppages and turns they cause, and by the encouragement to idleness in the men that their cover affords. I believe arable fields with large hedges and hedge-row timber round them, whose dimensions are under 8 acres, are seldom or ever worth a farmer's cultivation. I see much poor open down-land in profitable

cultivation, and large districts of enclosed land of far better quality ruinous to the occupiers; and I have not a doubt that to the difference in the size of the fields this may be principally if not entirely traced.

'The following is the history of Spring Park Farm, as derived from Mr. Davis by the deputation:—Spring Park Farm, in 1833, when first tenanted by Mr. Davis, had been seven months out of cultivation, and from 1808 to 1833 had always been in the hands of the wealthy owners. The late Mr. John Smith was fond of telling that when he bought Spring Park, about 1808 (then comprising about 600 acres), he found a tenant on it whose rent was 66*l.* per annum; that after two years the tenant failed, and he lost his rent. From that time to 1833 it was never let. Since Mr. Davis has rented it he has drained nearly the whole 4 feet deep; he has also trenched it 15 inches deep, taking out many hundred loads of conglomerate gravel that was broken up by a plough made on purpose. The result of this is, that he grows at least three times as much produce as formerly, and keeps five times the quantity of stock; the seasons are far kinder, and the land admits of winter-feeding with sheep, and early sowing. The name of this farm was formerly "Cold Harbour." It was then reckoned the coldest spot in the neighbourhood, and consisted principally of a wild heath, full of bogs, affording excellent snipe-shooting in the winter, and, as a neighbour used humorously to describe it, finding keep in the summer for a lark an acre. The late Mr. Maberley, when he bought it, not liking the name, re-christened it Spring Park, probably so designating it from the quantity of water springing up upon it; but deep draining and high cultivation have strangely changed its character. The forward state of the crops shows that it can no longer be fairly called "Cold Harbour," and latterly the springs have been diminishing, till at least half of them are stopped altogether, and corn now waves where heath alone formerly grew. Still no farmer will envy Mr. Davis his possession of such a soil. Much has been done, probably all that art can do, to improve it, but man cannot change gravel or sand; by draining he may make it dry, and by trenching he may multiply the space for roots to range in, and derive nutriment from; but a gravel or a sand, unlike clay, or chalk, or mould, admits of no further change, and to the last must ever be a hungry, uncertain bed for corn; a fast consumer of nutriment, much dependent on seasons, and requiring summer rains for maintaining continuously its vegetating powers in May and June.'

The course of cropping I have adopted to obtain the largest returns at least cost, is as follows, viz.: I divide my arable land yearly into fifths—

1-5th	is appropriated	to green and cattle crops.
2-5ths	,,	to cereal corn.
1-5th	,,	to legumes.
1-5th	,,	to hay.

and in the following rotation, viz.:—

1st year, in three portions, rye, winter barley, and tares.

These are used for green meat and sheep-feeding in April, May, June, and July, and as the ground becomes cleared it is well

dressed with manure, and sown, according to the season, with mangold wurzel, swedes, cabbages, and turnips.

2nd year, oats, or barley, with clover seeds.
3rd year, clover, affording 2 crops of hay.
4th year, beans or peas.

The beans are the sort known as the Russian or winter, and are sown in September and October, in drills 28 inches asunder; and in May, when they have been thoroughly cleaned, and the ground between has been well pulverised by the hand and horse-hoes, rows of turnips (the stone) are drilled in. After harvesting the beans the turnips undergo the usual hand and horse-hoeings, and by Michaelmas are ready for feeding off.

5th year, wheat.

In this way I obtain in five years 3 corn, 2 hay, and 2 cattle crops, and the turnips in the beans, and the land gets a liberal dressing of dung (besides the sheep manuring), a constant return of alterative cropping is kept up, and a cleansing crop alternates between the corn: by these means the land after each course is brought into a cleaner and more healthy condition, and its fertility goes on increasing.

My practice is to drill everything (except clover), to carefully hand and horse hoe and weed, so as to keep the land occupied and devoted wholly to the plants I wish growing, and to give to the vegetation the benefit of frequent stirrings and aëration. My rye, tares, and cereal corn, are all drilled 12 inches apart, and my beans, peas, and roots, at 28 inches; when this routine is established, the only dressing necessary is that for the green or root crops, and by cattle-feeding in sheds the mangold wurzel and half the swedes with oil cake, and a proper care of the manure, ample provision may be raised on every farm. In the spring the hoes are kept constantly moving, the hand-hoes in the narrow, and the horse-hoes in the wider drills, beginning in the latter with those with tines which break the surface and fetch up the root-weeds, and afterwards letting follow those with knives which cut off all surface weeds; by these means, and the free use of Finlayson's harrow after most ploughings, I have brought my land clean, and am able to entirely dispense with fallows.

The following calculations are drawn out to show that with even moderate returns and prices, and high rates of charges, a fair tenant's profit may be made by this practice:—

Dr.	COST, per Acre.	£.	s.	d.
1st Year.	RYE.			
	Broad shearing the wheat stubble	0	6	0
	Ploughing by 2 horses	0	10	0
	Harrowings and drilling	0	6	0
	Seed, 1½ bushel	0	7	6
	Sundries	0	5	0
	Half-year's rent, 10*s.*; rates and tithes, 1*s.* 6*d.*; management, 2*s.* 6*d.*; interest and extras, 6*s.*	1	0	0
		2	14	6
	TURNIPS.			
	Dressing dung, 20 loads, at 5*s.*	5	0	0
	Ploughing twice by 3 horses, at 12*s.*	1	4	0
	Ridging and splitting	0	14	0
	Harrowings, rolling, drilling, and scuffling, three times	0	13	0
	Seed, 3*s.*; sundries, 5*s.*	0	8	0
	Hoeing, weeding, and picking	0	10	0
	Half-year's rent, rates, &c.	1	0	0
		9	9	0
2nd Year.	OATS.			
	Ploughing by 3 horses	0	12	0
	Rolling, harrowings, and drilling	0	6	0
	Seed, 2 bushels	0	6	0
	Sundries	0	10	0
	Mowing, harvesting, stacking, threshing, and marketing	1	15	0
	One year's rent, rates, interest, &c.	2	0	0
		5	9	0

	RETURN, per Acre.	£.	s.	d. Cr.
1st Year.	Sheep-feed in April, valued at	1	5	0
		1	5	0
	Sheep-feed, valued at	3	0	0
		3	0	0
2nd Year.	Oats, 7 quarters, at 20*s.*	7	0	0
	Straw, 2½ loads, at 20*s.*	2	10	0
		9	10	0

	COST, per Acre.	£	s.	d.		RETURN, per Acre.	£	s.	d. *Cr.*
3rd Year.	SEEDS.				3rd Year.				
	Clover, and expenses of sowing	0	12	0		Hay, $1\frac{1}{4}$ load, at 80*s*.	5	0	0
	Rolling, stone-picking, and bush-harrowing	0	5	0		Ditto, second cut, $\frac{3}{4}$ load, at 60*s*.	2	5	0
	Sundries	0	5	0		Sheep-feed	0	10	0
	Twice mowing, haymaking, stacking, and marketing	2	10	0					
	One year's rent, rates, &c.	2	0	0					
		5	12	0			7	15	0
4th Year.	PEAS.				4th Year.				
	Ploughing deep by 4 horses	0	16	0		Peas, $3\frac{1}{2}$ quarters, at 32*s*.	5	12	0
	Harrowings, rolling, drilling, and scuffling three times	0	13	6		Haulm, $1\frac{3}{4}$ load, at 20*s*.	1	15	0
	Hoeing and weeding	0	6	6					
	Seed, 2 bushels	0	9	0					
	Sundries	0	10	0					
	Mowing, harvesting, stacking, threshing, and marketing	1	15	0					
	One year's rent, rates, &c.	2	0	0					
		6	10	0			7	7	0
5th Year.	WHEAT.				5th Year.				
	Broad shearing pea stubble	0	6	0		Wheat, $3\frac{1}{2}$ quarters, at 50*s*.	8	15	0
	Ploughing by 4 horses	0	16	0		Straw, 2 loads, at 28*s*.	2	16	0
	Harrowings, rolling, and drilling	0	7	6					
	Hoeing and weeding	0	7	0					
	Seed, 1 bushel	0	7	0					
	Sundries	0	10	0					
	Reaping, harvesting, stacking, threshing, and marketing	2	0	0					
	One year's rent, rates, &c.	2	0	0					
		6	13	6			11	11	0

Dr. SUMMARY. *Cr.*

	Cost, per Acre.	£. s. d.	£. s. d.		Return, per Acre.	£. s. d.	£. s. d.
1st Year.	Rye	2 14 6		1st Year.	Sheep-feed, valued at . .	1 5 0	
	Turnips	9 9 0	12 3 6		Ditto ditto . . .	3 0 0	4 5 0
2nd Year.	Oats		5 9 0	2nd Year.	Oats and straw, 7 quarters . . .		9 10 0
3rd Year.	Seeds		5 12 0	3rd Year.	Hay, &c., 2 loads		7 15 0
4th Year.	Peas		6 10 0	4th Year.	Peas and straw, $3\frac{1}{2}$ quarters . . .		7 7 0
5th Year.	Wheat		6 13 6	5th Year.	Wheat and ditto, $3\frac{1}{2}$ quarters . . .		11 11 0
			36 7 0				
	Profit (besides interest on capital at 5 per cent. per annum, and living rent free) in 5 years, or per acre per annum 16*s.* $2\frac{1}{2}$*d.* . .		4 1 0				
			40 8 0				40 8 0

The manure being charged at 5*s.* per load on the debit side, it is right to give credit for the straw at rather more than a mere consuming price.

Hewitt Davis,

3, *Frederick-place, Old Jewry.*

London, 11 *November,* 1846.

If any excuse be required for trespassing to a greater extent than may be thought necessary, I feel sure that our mutual desires to benefit all agricultural classes will be accepted both as your apology for thus honouring me with your expressed wish that I should supply this account, as well as mine for having extended it to such a length.

I have the honour to be,
Dear Sir,
Your very obedient servant,
HEWITT DAVIS.

3, *Frederick Place, Old Jewry, London,*
Nov. 2, 1846.

My experience as to trenching and subsoil-ploughing differs entirely from that stated in this Essay. The success of Mr. Davis should be tested by figures, and must depend on the time he takes to complete his depth of 14 or 15 inches. If it is very gradual, year by year a little new soil brought up, then it may be generally advantageous; but if it is a regular trenching at once, I advise no one to venture, until after some experience and detailed evidence, *largely* to follow that plan. No. 8 Rule admits of great doubt. I have lately seen great success attend the opposite system in the hands of one of the best arable farmers in England.

PORTMAN.

XXXIV.—*On Thick and Thin Sowing.* From Sir W. HEATHCOTE, Bart.

SIR WILLIAM,—Having in 1813 received your instructions to try the experiment of thin sowing on a portion of your land intended for wheat in that year, (but unfortunately at so late a period of the season (29th Nov.) that the trial did not have a fair chance: 1st, because, however well the land may be cultivated, I believe it essential to a good crop that thin sowing be accomplished early; and 2ndly, because, in addition to lateness, in this instance only a small field remained to be sown, and that recently taken in hand and very much out of condition,) I proceeded immediately with the work, and portions of half an acre each were drilled with 2, 3, 4, 5, and 6 pecks of wheat.

From the above causes the whole turned out a failure, and the thinnest the worst, the lateness of the tillering having prevented uniform ripening, and the bad state of the land having hindered any forcing which under more favourable circumstances might have taken place. With these drawbacks there were nevertheless

some very fine ears amongst the thinnest sown, and enough to show that under good husbandry a good crop was possible; and on seeing the crop, your order was to continue the experiment in 1844.

This was set about very carefully at the home farm in the middle of a field which had been twice mowed, clover ley well manured from the farm-yard, all the field (22 acres) as nearly done alike as possible: the field was all drilled first, to plug No. 1 of the experiment with 9 pecks of wheat per acre; then followed the thin sowing in parcels of 2 ridges each, No. 1 being drilled at the rate of 3 pecks per acre; No. 2, 4 pecks; No. 3, 5 pecks; No. 4, 6 pecks; and No. 5, 7 pecks; the remainder of the field being drilled at the rate of 9 pecks per acre.

Owing to an attack of wireworm, which damaged in a certain degree the whole experiment, this trial was not altogether satisfactory: it was however so far encouraging as to warrant the reduction of seed over the whole crop sown in 1845 to a very considerable extent, and the curtailment of the number of lots in the trial also to 3, beginning with 4 pecks and finishing with 6, the highest quantity sown being only 8 pecks, and that the least portion of the crop.

The exact result of the experiment in the two last years is given below, and it may be well to mention here, that in consequence of the good appearance of the thinnest sown in the spring of this year, I was induced to sow 34 acres with only 68 bushels of oats in a field where we had carted off about 21 tons of Swedish turnips to the acre, and the promise of the oat crop is highly satisfactory, notwithstanding the protracted sowing from the continued wetness of the winter and spring. We are now preparing with all dispatch the land for this year's wheat sowing, the greater portion of which will be done with 4 pecks to the acre, increasing up to 6, only as the season advances, and giving to the thinnest sown the chance of early tillering, an advantage second only to high cultivation in securing good crops from reduced quantities of seed corn.

I remain, &c.

Hursley Park, Hants. W. Fowlie.

Experiment reaped in 1845, *carried to the mill, and threshed at once.*

Lots.	Measure.		Pecks sown, at rate of	Sheaves in lot.	Produce in best.			Weight per bushel.	Produce, seconds.			Weight per bushel.	Straw.		
	R.	P.			bush.	ps.	gs.	lbs.	bush.	ps.	gs.	lbs.	cwts.	qrs.	lbs.
1	2	10	9	447	23	3	0	65½	2	1	0	56	11	0	17
2	2	11	7	251	16	2	1½	63	1	2	0	59	7	2	12
3	2	9	6	331	18	2	1	62½	1	0	3¼	56	9	3	0
4	2	12	5	284	16	2	1½	62	0	3	1	49	8	1	19
5	2	8	4	285	19	0	1½	62	1	0	0	55	9	2	5
6	2	7	3	326	18	0	1½	61½	0	3	1	38	11	1	11
7	2	18	9	539	21	0	1	63	1	0	0	56	12	2	19

Experiment reaped 1846, *threshed immediately.*

No.	Measure.		Pecks sown, at rate of	Sheaves in lot.	Produce, in best.			Weight per bushel.	Produce, seconds.	Weight per bushel.	Straw.			Amount per acre, best.		
	R.	P.			bush.	ps.	gs.	lbs.	gals.	lbs.	cwts.	qrs.	lbs.	bush.	ps.	gs.
1	1	11	4	218	12	2	0	62	1	52	7	0	0	41	0	1
2	1	11	5	216	12	0	0	62	3	55	8	2	0	37	2	1
3	1	11	6	170	11	0	0	62½	3	55	8	0	0	35	2	0

XXXV.—*Experiments in Thin Sowing.* By J. J. Mechi, Tiptree Hall, near Kelvedon, Essex.

Name of Field.	When sown.	How deposited.	Quantity of Seed per acre.	Quantity of Land.	Produce per acre.	Quality of Soil.	REMARKS.
	1845.				Bushels		
Elm. .	Oct. 29	Bentall's Dropper	4 pecks	3 acres	40	Poor tile earth, very tenacious	2 to 3 kernels in each hole, 6 inches from row to row.
„	„ „	Newberry's Dibbler	4 „	3 „	38½	„	8 to 9 kernels in each hole, 11 inches from row to row.
Ash . .	Nov. 1	Bentall's Dropper	4 „	1 acre	35	„	Most straw and corn from the smaller quantity of seed.
	„ „	Drill	8 „	5 acres	34½	„	
Crooked Ridges	„ 21	Newberry's Dibbler	2½ „	1 rood	30½	„	The thin-sown a week later in ripening.*
		Drill and Dibbler	9 „	3 acres	32	„	
The Bog	Nov. 10-20	Bentall's Dropper	4 „	1 „	48	Felty bog	The 4 and 5 pecks were unfortunately not kept separate. The smallest quantity of seed was estimated as the greater produce.
		Hand-dropped	5 „	1 „			

* I have invariably found the same result occur.—W. Miles.

The quality of the wheat was good, weighing 63 and 64 lbs. per bushel. The straw strong and bright. The straw was larger and longer, and the ears largest, where thin-sown. My harvest commenced on the 14th July, and was completed on the 14th of August. I had only half an acre of wheat laid on 80 acres; about 20 acres more were dibbled on my light land with 4 and 5 pecks per acre.

No exact result is known, but they are estimated to produce from 40 to 44 bushels per acre, with abundance of straw. The land was very free from weeds; principally hoed by Garrett's horse-hoe.

Experiments in 1845.

1 peck of barley, dibbled 27th April, by Newberry's dibbler, on one-third of an acre of light soil, naturally poor, but fairly manured, produced 2 quarters, or at the rate of 6 quarters per acre.

Two fields of wheat were drilled, half with 1 bushel, 12 inches apart, half with 2 bushels, 6 inches apart.

In both cases the produce was as nearly as possible equal, athough the thickest sown *appeared* rather the best.

Thin sowing should be *early* sowing on heavy land. I consider I have been later in sowing than I ought to have been. It would be a dangerous experiment to sow thinly, unless the land were drained, subsoiled, and kept quite free from weeds by the horse-hoe. Some allowance should be made for game near preserves. On my light land and bog, my wheat plants would have been destroyed by wire-worm, had I not rolled them twice over in the spring with Crosskill's roller. On reclaimed bog, or deep rich vegetable soil, I find it imperative to sow thin, say 3 to 4 pecks per acre, or the crop would be mostly straw. Even with this quantity I had to flag my wheat three times on the bog, and then it was partially laid, especially so where 5 pecks per acre were used. Thin sowing somewhat delays the ripening of a crop, especially if sown on heavy land so late as November or December. In cold or elevated districts, thin sowing, to succeed, must be very early. In my experiments, anything beyond 1 bushel of seed per acre has not had the effect of increasing the yield, the extra seed being lost. It is a singular fact, that the 1 bushel per acre never changed yellow in the spring, but went on with a healthy green cast without a check. The 2 bushels turned yellow, and the 3 bushels yellower, and was decidedly the worst stetch in the field. I would venture to suggest that each farmer should satisfy his own mind, by trying part of an acre on each field.

We seldom hear complaints of the losses from *thick* sowing in

rich soil. They are, however, very serious in moist luxuriant summers.

Two friends of mine sowed 4 bushels per acre, and only got 4 quarters of grinding barley, which sold at 27*s.* 6*d.* They had an abundance of crowded weakly straw, which was laid early; mine dibbled, at 3 pecks per acre, in not near so good a soil, produced 6 quarters, which sold for 33*s.* 6*d.*, with strong straws, and ears containing 17 to 19 kernels on each side. This was in 1845.

It is a fact worth observing, that where I sowed 1 bushel per acre of wheat, I have a plant of clover, but have no plant where I used 2 bushels, although in the same field. I drill the clover on the wheat in the spring.

I. J. Mechi.

September 26, 1846.

XXXVI.—*On Peat Charcoal, as a Manure for Turnips and other Crops.* By Hugh Raynbird of Hengrave.

Prize Essay.

The use of Peat Charcoal as a manure for turnips and other crops, proposed as a subject of investigation by the Royal Agricultural Society, is one that calls for the consideration of many of the cultivators of the soil; for on many farms a portion of peaty land is to be found suitable for the preparation of charcoal; and when this happens to be the case, a valuable manure may be procured for the mere cost of the labour required in the operation of charring. Peat charcoal, being manufactured at home by our own labourers, and consequently not subject to a long and expensive carriage, as most of the new fertilizers are, has a decided advantage over many of our other manures that are, as it were, the products of a foreign country; and thus, coming from a distance, take a considerable sum from the pocket of the farmer, though they frequently add but little to the immediate employment of his labourers.

It is only within the last few years that peat charcoal has been prepared for the purpose of manure; and it may be said to owe its introduction to the impetus which has been given to agriculture by the efforts of those who have the management of the Royal Agricultural Society of England. But though charred peat ranks as a new manure, yet the ashes formed by burning peat have been used for upwards of a century in Berkshire and other parts of the country.

The difference that exists between the two manures arises entirely from their distinct mode of preparation. The peat char-

coal is burnt in heaps, so that the air has not much access to the fire, which is put out as soon as a sufficient quantity is charred. By this means the carbon contained in the peat is left unconsumed, as is proved by the ashes being black in colour. The heaps in which peat-ashes are burnt are suffered to consume away with full access to the air till the fire goes out of itself, which it hardly ever does till all the organic or combustible part of the peat has been consumed, leaving unburnt the inorganic or incombustible portion which in some peat soils exists, but in a very small proportion to the whole bulk.

Peat-ashes may be very useful as a manure, if the peat happens to contain such inorganic substances as carbonate of lime, sulphate of lime, or other fertilizing earths. It is to the presence of these substances that the famous peat-ashes of Holland, and those of Newbury, owe much of their fertilizing powers: the latter contain a portion of lime, which, in the course of ages, has been washed from the chalk hills down to the peat that has accumulated in the valleys. Should the peat have but a small proportion of inorganic matter, and a portion even of that may be of a deleterious nature, we may burn our heaps till they are almost entirely consumed, and but few ashes remain to repay us for the trouble we have taken; and these, from some injurious substance contained in the peat, of little value when applied to the land.

The sources from whence peat derives its inorganic substances are the foundation upon which it has accumulated; in course of time the earthy matter which lies beneath will, in a greater or less degree, become intermixed with the overlying mass of peat. Inorganic matter is also washed from any higher ground that may surround the peaty district, and earthy matter has been brought by rivers from other formations, and these rivers, having overflowed their banks, have deposited on the peat any earthy or vegetable substance brought down by the water; in this manner those rich alluvial tracts of land which border on our rivers have been formed.

Real peat is composed principally of organic or combustible matter produced by the gradual decay of plants which have grown in moist situations; the remains of these plants form a soil and seedbed for the vegetation and growth of a succeeding generation of plants of the same tribe, and as these die and decay they add to the mass; and thus the peat or bog goes on gradually accumulating so long as the situation is favourable to the growth and partial decay of plants. In this manner has a large extent of country become covered with inert vegetable matter, which, in its undrained and uncultivated state, is but the habitation of wildfowl, barely of sufficient solidity to allow the passage of man or of small animals over its wet and swampy surface, but capable by

draining, claying, and good cultivation of being converted into the most productive soil. The decomposition of the vegetable matter of which peat is formed is very tardy, and it differs widely from the action which takes place when we heap a large quantity of the common vegetable or animal substances together; when this is done, heat is produced, and the putrefactive fermentation comes on. But the vegetable remains of which peat is composed seldom or never take on the putrefactive fermentation unless it is by the addition of some other materials; the want of this is one cause of the inutility of peat, when used as manure before it has undergone any preparation. The non-decomposition of peat arises from the low temperature caused by the great excess of water with which it is saturated, as well as from the tannin property contained in the plants of which peat is composed; and it is to these causes it owes its antiseptic, or preservative quality, by which animals, trees, and other substances have been kept in an undecayed state for several hundred years from the time they were first imbedded under the surface.

Having thus given a short description of peat, we shall proceed to consider the property of charcoal. Chemically considered, carbon or charcoal, either prepared from wood or peat, may be said to derive its use as a manure from its property of absorbing moisture, as well as from its power of taking up the different gases, particularly ammonia. Charcoal, by absorbing moisture, keeps the soil sufficiently damp for the vegetation of the young plants, besides giving out its stores of ammonia and other gases to assist in their future growth. Another valuable purpose to which peat-charcoal may be applied is that of fixing the ammonia and other volatile bodies that arise from liquid manure; and it may also be used for the same purpose by mixing it with the common manure heap. A celebrated chemist says, "that wood-charcoal, reduced to powder, charred sawdust, and *charred peat*, are all capable of being used with advantage in extracting the ammoniacal and other salts which give its value to the liquid of the farm-yards. Experiment has shown that, when filtered through a bed of such charcoal, the liquid escapes without colour, and almost without taste; while the charred peat or sawdust is itself converted into fertilizing manure."

We learn from men of science the theory of the use of charcoal as a manure; and practical men have, in many instances, proved its efficacy. Drilled with turnips, or the seeds of other roots, it is found to cause a quick vegetation of the seed, which is often the only thing wanting to secure a good crop; the plants, by their quick growth, stand a much better chance of escaping the fly and many other enemies which destroy them in a young state.

An instance of the quick vegetation of the seed, produced by

the use of powdered charcoal, was very plainly shown on a farm where I had opportunity of making observation. During the exceeding dry summer of 1844, wood charcoal, powdered fine, was drilled with carrot-seed, with which it was well mixed to prevent the seed clogging in the drill; it served two purposes: the seed was deposited with great regularity in the drills, and the carrots made their appearance above ground, notwithstanding the dryness of the weather, in a few days, and in sufficient numbers to constitute a full plant; the crop was good for the year, being upwards of 500 bushels per acre, which was equal, or superior, to any crop in the neighbourhood, where, from the dryness of the season, the crops of this root were a failure; this arose principally from the seed not having a sufficient amount of moisture in the soil for its vegetation. It may be asserted the carrot-seed would have grown equally well without the addition of the charcoal, and it is to be regretted that no certain trial was made at the time by drilling part of the field with seed alone, and part with seed mixed with charcoal. The dry season of 1844 would have shown the efficacy of charcoal, as a manure, much better than one in which the average amount of rain falls.

We must now pass from these introductory remarks to the real subject of our essay, and I shall describe, in as concise and plain a manner as possible, that which has come under my own practice and observation relating to the use and preparation of peat-charcoal; in doing this, we are required to attend more particularly to the following points:—

1. Quality of peat.
2. Mode of making the heaps and burning the charcoal.
3. Quantity produced from a given measure of peat.
4. Quantity applied per acre, and effect in comparison with some other manures.

1. *Quality of Peat.*

I have already stated the causes which affect the quantity and quality of the earthy or inorganic matter found in peat; and as these add to or lessen the value of peat ashes, they also affect the quality of the charcoal, though certainly to a much smaller extent, for, as far as practice can judge, the ashes, burnt, as they often are, to a light or red colour, appear to have lost all or the greater part of the carbon contained in the peat, and must owe their chief use as a manure to the earths and salts which remain after combustion has ceased. On the other hand, the charcoal being burnt only till it assumes a black colour, has all the earthy materials as well as a great proportion of the carbon, thus securing a more valuable manure by the consumption of a smaller amount of peat. The quality may be

considered particularly adapted to the purpose of preparing charcoal when the peat contains calcareous matter in any of its forms, either as carbonate or sulphate of lime,—these may sometimes be found in the multitude of small shells that occur in the peat; clay may also add to its value as a fertiliser on certain kinds of land. As to the peat itself, I should not recommend that which is very light or spongy in its texture, as it will waste much in the process of charring; nor would I select that which has a bad drainage, for it will then be saturated with water, and its surface will be liable to be flooded by heavy rains, and in consequence of this there will be great difficulty in getting the peat dry enough for charring. However, these objections may be obviated by draining, which will cause the peat to become more solid; it will then be better to dig, and will dry in a shorter space of time. To give a correct description of the quality of the peat from which we prepare charcoal, I ought to give its chemical analysis; but to go to the expense of having an analysis made on the mere chance of having this essay approved by the Society, will be a hazardous expenditure. I shall, however, have much pleasure in forwarding samples of the charcoal, and also of the peat itself. The following imperfect analysis may, perhaps, give an insight into the character of the peat employed. A sample of peat was taken at 2 feet from the surface during dry weather, and at the usual season of charring; 500 grains dried at 212° Fahr. diminished to 89 grains. The 89 grains exposed to a red heat were reduced to 35 grains, which were all the ashes obtained from 500 grains of peat, or only 7 per cent.

The analysis stands as follows in 100 parts:—

Water	82·2 grains.
Vegetable matter . . .	10·8
Ashes	7·0
	100

The 35 grains of ashes, being tested, gave silica, potash, and sulphuric acid in large, and lime and iron in small, proportions. On the ground for drying and burning peat, of which I have given a plan, the peat lies from 3 to 5 feet in thickness, and rests upon a gravelly subsoil. It was underdrained a few years since, but still in wet weather it would not allow the passage of heavy cattle over its surface; it produced very bad crops, and its value to rent might be about 10*s*. per acre.

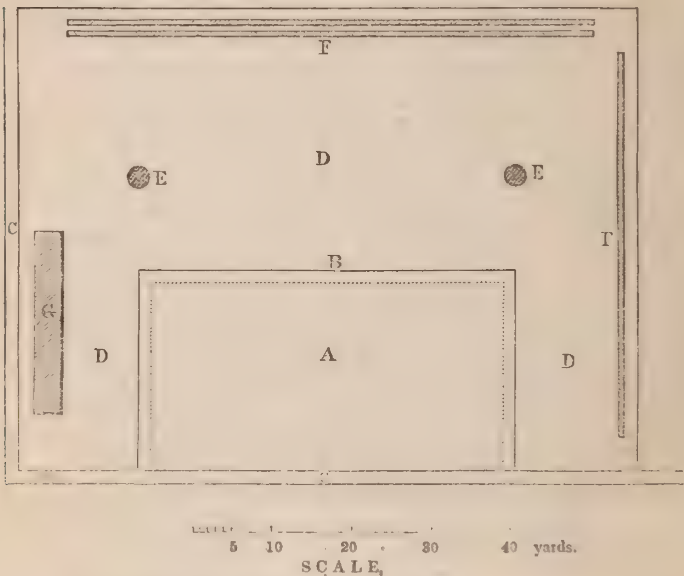
2. *Mode of making the Heaps and burning the Charcoal.*

Before we proceed to these operations, we must select a piece of ground suitable for the digging and drying the peat. The best situation is on one side or corner of a field that has a good exposure to the sun and wind; by giving the preference to the corner of a field.

we shall have ditches on two of the sides, from which water can be taken to quench the fires; the ditch-sides will also be the driest and most convenient place for stacking or storing the charred peat.

We now begin by digging a trench on one of the sides that are bordered by a ditch, of about 5 feet in width. The peat dug from this is removed in barrows to the drying-ground, and thinly and evenly spread over its surface. When all the peat is dug from

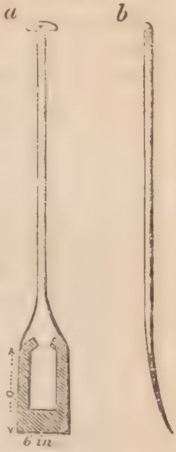
Plan of Ground for Charring Peat.



A. Pit from which peat has been dug.
B. Trenches for raising peat.
C. Open drains or ditches.
D. Drying-ground.
E. Fires.
F. Sods stacked for drying.
G. Thatched rick of charred peat.

the first trench another is begun, and the digging proceeds at that part of the trench which is nearest to the portion of the drying-ground which requires to be covered. About 6 inches of the surface of each trench is not used for burning, but is thrown into the pit for the purpose of affording a soil for future cultivation. After the peat has laid for a few days on the drying-ground, it will require to be well stirred by means of a rake with long iron teeth; this brings the lower and wet pieces to the surface. Should it continue dry weather for three or four days after the raking, the peat will be sufficiently dried, and may be gathered into heaps; it will generally be found to have wasted to one-half its former bulk. It may either be barrowed directly to the fires, or

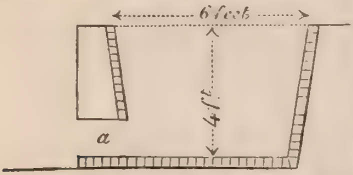
laid in heaps ready for throwing on the fires, the ground from which it is taken being immediately filled with fresh peat from the trenches. Some portion of the peat is dried by having sods or turfs stacked up in a similar manner to bricks before they are burnt. A peculiar kind of spade is used in digging the sods; it requires some skill in its use, but any one accustomed to it will find it a much better tool for the purpose than the common spade. This spade is chiefly made of wood, with the exception of the cutting part, which is shaded in the drawing; this is of thin iron. *a* shows the front, and *b* the side of the spade. The sods are some time in drying; but as they do not occupy much space, a supply of them is useful, when from wet weather the peat that lies on the ground is too damp to burn.



Having got together a supply of the dried material, we may proceed to the charring process. A quantity of peat is thrown over a small heap of bushes, furze, or other dry fuel, an aperture being left on the windward side for lighting the fire. As soon as the fire gets a good hold, more peat is laid on, and this is continued to be supplied at regular intervals. In tending the heaps, the fire must never be allowed to make its appearance on the outside, but the heaps must be sufficiently covered in to prevent the access of the air to the combustion which is gradually going on. However, if we lay on too large a quantity at once, there is some danger of putting the fire out; more particularly when the peat is wet, or the fire but recently lighted. The fire should not continue burning many days; for if it does, the heap will so accumulate from the peat with which it is supplied, that there will be great difficulty in extinguishing the fire in proper time. Before putting out the fire a quantity of the dust or small peat, from which the large pieces have been sifted or screened, is laid over the heap; by this means all the peat which has been put on previously becomes charred, the fire being prevented by the dust from breaking out on the surface. The heap is now pulled down with a long crome similar to those used in dragging the weeds from rivers and ditches, and a sufficient quantity of water thrown on the fire to extinguish it altogether; if there is much difficulty in putting the fire out, the heap may be turned over, and water applied as the process of turning proceeds. There is no use in throwing a few pailfuls of water over the heap, and then allowing the fire to smoulder underneath; for though the outside has the black appearance of charcoal, yet the fire will continue to burn in the

centre of the heap without giving off much smoke till it breaks out on the surface, and converts the whole of the centre of the heap into ashes. It must be remembered that charcoal is quite as combustible, or rather more so, than peat itself, so that, when we merely extinguish the fire on the outside, the fire that remains soon breaks out again. When the fire is completely extinguished, the ashes will have a black or charred appearance, quite different from the red colour of those heaps that are allowed to burn out of themselves. It is usual to have two heaps burning at the same time, one on each side of the drying-ground; for, by adopting this plan, the distance for removing the peat will not be so great as it otherwise would be by having only one fire. At the end of the burning season all the charred peat is removed to a dry and level piece of ground, to be stored away till wanted for use; it is first laid in a rectangular form of about 12 feet wide, 3 feet deep, and to any convenient length. This is to facilitate the measuring the quantity charred, the practice being to pay from 4*l.* 10*s.* to 5*l.* per 1000 bushels, reckoning 25 bushels to each cubic yard. After the number of bushels in the heap has been ascertained, the charcoal is thrown up in a triangular form, resembling the roof of a house, and is then thatched with straw or haulm to keep out the wet. Should the heap be placed on a wet spot, a trench will require to be dug round it to carry off the water, which would soak into the bottom of the heap. The best season for charring is from March to October.

We have tried other ways of burning peat, such as covering the heap with turf to keep out the air; but this would not succeed unless water was used to put the fire out. We also made a small kiln, which, though of no use for charring, yet answered remarkably well for burning chalk with the dried peat. This kiln was made by digging a hole near the side of a trench, from which the peat had been dug for burning, and then lining it with bricks; the following drawing shows a section of the kiln. A fire was made in the kiln, and peat and chalk applied in alternate layers; as it was burnt the lime and peat-ashes were drawn from the mouth (*a*).



3. *Quantity produced from a given Measure of Peat.*

This of course depends a great deal upon circumstances; it varies with the kind of peat, with the quantity of water contained in the peat, as well as with the earthy matter contained in it, and upon the state of decomposition which the peat is in.

When the peat is saturated with water it wastes considerably; frequently more than half by the drying process alone.

In 1845 the quantity of peat dug was 578 cubic yards; this produced 140 cubic yards of charred peat; thus, 1 cubic yard, equal to 21 bushels, would waste by drying and burning to about 5 bushels, or to about 1-4th its bulk when dug.

From experiments on a small scale I had the following result: fresh dug peat, taken from different depths, lost 3-4ths of its weight on being exposed seven weeks to the sun and wind; half of this was lost in charring, and half of the weight of charcoal was lost on burning it to ashes.

Peat taken from the dry fibrous part at the surface will lose less weight in drying, though more in burning. If taken from a lower and more earthy part it will lose less in burning, though more in drying. Farmers entertain different views of charring: one will call that charred which is merely dried and blackened by smoke, and others call mere ashes charcoal.

4. *Quantity applied per Acre, and effect in comparison with some other Manures.*

I have previously mentioned the power of charcoal as a fertilizer in hastening the germination of the seed, and on this account alone charred peat may with great advantage be used as a manure for root-crops. Its manner of application may be broadcast by hand, or with the shovel; this may be better performed by means of a broadcast drill,* or by drilling in rows at the same time as the seed by the common manure-drill. For the latter purpose it is a cheap and excellent substance for mixing with the more expensive artificial manures previous to their application, such as guano, bones, super-phosphate of lime, &c. &c. Ashes are frequently added to artificial manures; but an objection to their being used in a dry state (which by the way is the only state in which they can be applied by the generality of drills) is this: that, should dry weather follow the sowing, the dry ashes, being under the seed, will retard its germination. It is perhaps hardly necessary to mention that the charred peat will require to be sifted before it is drilled. The large pieces that will not pass through the sieve can be pulverised by a rammer, or by drawing a garden-roll over them.

The quantity used per acre will of course vary with the circumstance of the crop: when drilled in rows, with or without the addition of other artificial manure, the quantity need not exceed

* Mr. Crosskill of Beverley has constructed an excellent implement for sowing manures, which, I believe, has been approved by the Royal Agricultural Society.

from 20 to 40 bushels per acre; when drilled broadcast, from 100 to 150 bushels will not be a very expensive dressing.

I have never made any very careful experiments with peat-charcoal in comparison with other manures; but if we may be allowed to judge from appearances, the results are evidently satisfactory. As an instance, on July 2, 1845, 40 bushels per acre of peat-charcoal were drilled with green-top Aberdeen turnips on a light sandy loam, the previous crop being rye and vetches mown for soiling. The young plants appeared above ground in a short space of time, and were singled out within a week, as soon as turnips of a quicker growing kind that had been drilled twelve days earlier with 1½ cwt. of guano mixed with peat-ashes per acre; this was on the same description of soil, the previous crop being rye fed off with sheep, and the land then manured with 15 cart-loads per acre of farm-yard dung; the other, in addition to the peat-charcoal, had been folded. The crops were good, but the cost of the peat-charcoal was barely one-half that of the guano, without taking into consideration the extra dressing of farm-yard manure.*

This essay is now brought to a conclusion; and though it is imperfect in many respects, yet sufficient has been said on the subject to show that, where peat can be conveniently dug, it will be to the farmer's advantage to make use of it as a manure in the shape of peat-charcoal; if it is merely used as an addition to the solid or liquid manure of the farm-yard, it will amply repay the expense of preparation.

The removal of a bed of peat three or four feet in thickness will be no injury to the soil; where there is a good drainage it will in all probability increase the fertility of the land; and even when the water cannot be drained from the hole which has been excavated, it may be rendered valuable by being converted into a plantation of osiers, or, if water covers the surface, into a pond for the cultivation of the common reed (Arundo phragmites), which will be invaluable for the purpose of covering farm-buildings.

Cirencester, Nov. 28, 1846.

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* The crop of turnips to which the peat-charcoal was applied in 1845, was fed off late in the spring of 1846; the land ploughed and subsoiled, and on May the 9th drilled with Belgian carrots; the seed being mixed with 2 bushels per acre of powdered wood charcoal: notwithstanding the dry weather the carrots came up well. The produce was about 1200 bushels per acre, and each bushel of carrots weighing 3 stone 3 lbs., will give upwards of 24 tons of roots per acre, exclusive of the tops. The only manure, besides the 2 bushels of charcoal, being the folding of the sheep while feeding the previous crop of turnips.

XXXVII.—*On the Fairy-Rings of Pastures, as illustrating the Use of Inorganic Manures.* By JOHN THOMAS WAY, Professor of Chemistry at the Cirencester College of Agriculture.

Note.—This paper was read at the Chemical Section of the British Association at Southampton.

MOST persons who live in the country must have observed that peculiar growth of grass in pasture lands to which the name of Fairy-rings is given. The fanciful name which these rings bear is to some extent an indication of the doubt which has always attached to their origin, and they have accordingly attracted very considerable attention, and much ingenious speculation has been exercised to account for their formation.

The appearance of these rings is due to grass of a darker colour and far more luxuriant growth than that of the surrounding herbage. The grass grows in bands of about a foot in breadth, and in rings which are more or less perfect and of all sizes; it is always the first to vegetate in the spring, and keeps the lead of the ordinary grass of the pastures till the period of cutting it arrives.

If the grass of the fairy-rings be examined in the spring and early summer, it will be found to conceal a number of Agarics or "toadstools" of various sizes. They are found situated either entirely on the outside of the ring or on the outer border of the grass which composes it.

The varying diameter of the rings has given good reason to suppose that the larger ones have undergone a progressive increase from those of smaller size, and consequently that these latter must have originated either in a single point or in a ring of very small dimensions. Competent observers have watched the rings from year to year, and assert that this is actually the case.

Omitting the consideration of the many theories which have been offered in explanation of these curious rings, I shall only remark that by far the most scientific and intelligible solution of the question is that which was based upon Decandolle's theory of the excretions of plants.

It was supposed that from one cause or another the germ of a fungus or Agaric became deposited on some point of a piece of pasture land—that the fungus formed from it, after passing through the various stages of its growth, shed its seed or sporules necessarily in a circle exterior to its point of connexion with the ground, and that in the following season a series of these plants was produced in the form of a small circle.

This new crop would in its turn come to maturity, shedding seeds both towards the centre and on the outside of the ring. Were circumstances favourable to the development of the seeds deposited on the inside of the ring, the diameter of it might increase indeed, but it would have the form, not of a ring with an open centre, but of a flat disc. This, however, does not take place: the fungi of one year are replaced in the next by a crop of luxuriant grass, to whose superior height and dark colour is due the appearance of the ring itself.

Now it was argued, upon the Decandollian theory, that the excretions of the fungus were in the highest degree injurious to its subsequent development on the same spot; but that, on the other hand, they were parti-

cularly favourable to the growth of the grass which followed them. It may easily be seen that this explanation is abundantly sufficient for every circumstance of the case, if the theory of Decandolle as to the excretions of plants were generally tenable.

It is needless for me to remark, however, that this theory has been abandoned by most vegetable physiologists, and has lately met distinct confutation from the laborious investigations undertaken by Dr. Daubeny on the rationale of the rotation of crops. It becomes then necessary to seek some other explanation for the formation of the fairy-rings. In the spring of this year it occurred to me to make a *chemical* examination of these fungi, with the hope of throwing light upon their peculiar growth; and I was favoured with an excellent opportunity of making this examination upon several magnificent rings growing on the pasture land surrounding our College.

My friend and colleague, Mr. Woodward, has furnished me with the following botanical description of the Agarics:—"The Agarics were not the small Fairy-ring Agarics (*A. Oreades*) which usually occur under such circumstances, but a much larger species attaining a diameter of from 4 to 6 inches, and having a thick solid stem and top. The Agarics when fresh are nearly white, turning brown gradually as they approach the period of decay; they are brittle, have no juice, and are nearly tasteless. A sketch which was sent (through the secretary of the London Botanical Society) to the Rev. M. J. Berkeley, was returned with the following memorandum:—'*This is the true St. George's Agaric of Clusius, or at least nearly allied to it—Agaricus graveolens*, Sow.' (A. fastibilis, Pers.) It appears to be as famous for producing Fairy-rings on the Continent as with us."

The fungi were gathered early in the month of May, after two or three dry days. Two of them, one large, the other small, were dried at a water-bath heat. They contained

87·46 per cent. water,
12·54 per cent. dry matter.

8 or 9 lbs. of fungi were burned, and yielded an ash which attracted moisture with great avidity from the air.

The quantity of ash yielded by the *un*dried fungus was 0·80 per cent., or, calculated on the dry weight, 6·38 per cent.

The analysis of the ash gave for its composition:—

Ash of Fungus.

Silica	1·09
Lime	1·35
Magnesia	2·20
Peroxide of Iron	trace.
Phosphoric Acid	29·49
Sulphuric Acid	1·93
Carbonic Acid	3·80
Potash	55·10
Soda	3·32
Chloride Sodium	0·41
	98·69

Here then we have an ash of extraordinary richness in some of the inorganic elements of vegetable life. The phosphoric acid and potash are as nearly as possible in the proportion to form the tribasic phosphate ($^3K\,O, P\,O_5$), and as such no doubt they exist. It is highly deliquescent, and therefore renders the ash peculiarly liable to attract moisture.

It will be seen that the phosphate of potash constitutes nearly 86 per cent. of the whole ash—a quantity of this substance which does not exist, as far as I am aware, in the ash of any other vegetable substance, wheat not excepted. It is to be observed that the fungi contain a great quantity of nitrogen. In decaying, as they did about the end of May, when the dry warm weather set in, they did not appear to become detached from their roots, but merely to shrivel up, without, as far as I could ascertain, giving off any putrid smell. On the other hand, if gathered and placed in a heap, they rapidly ferment, running into a liquid of the most disgustingly putrid smell, in every way resembling that of decomposing animal matter.

The grass which formed the ring was more than twice the height of the general grass of the pasture. It consisted principally of the perennial rye-grass (*Lolium perenne*, L.) and cock's-foot (*Dactylis glomerata*, L.) The interior of the ring was occupied in great measure by the soft Brome grass (*Bromus mollis*, L.), and other inferior and short-lived species.

The grass of the ring gave on burning an ash of a deliquescent character, having the following composition:—

Ash of Grass of Fairy-ring.

Silica . . .	16·10
Lime . . .	10·47
Magnesia . .	2·49
Peroxide Iron .	2·93
Phosphoric Acid .	6·54
Sulphuric Acid .	5·40
Carbonic Acid .	12·47
Potash . .	35·23
Soda . .	none.
Chloride Sodium .	5·79
	97·42

Upon comparing the composition of the ash of the grass with that of the fungi, it will be seen that the former contains phosphoric acid and potash in considerable quantity, although by no means to the extent of the fungus. It must be remembered, however, that the grass, besides being in far greater quantity, contains also more than twice the amount of ash yielded by the agaric.

On the foregoing analyses I think we may clearly explain the whole growth of the Fairy-rings. A fungus is developed on a single spot of ground, sheds its seed, and dies. On the spot where it grew it leaves a valuable manuring of phosphoric acid and alkalies, some magnesia, and a little sulphate of lime. Another fungus might undoubtedly grow

on the same spot again ; but upon the death of the first the ground becomes occupied by a vigorous crop of grass, rising, like a phœnix, on the *ashes* of its predecessor.

If the grass shared the fate of the agaric, withering and dying on the land, its growth might continue, the circle might increase and remain as before supposed in the shape of a disc ; but in *practice* this does not occur—the grass is either eaten off by cattle or taken away in the form of hay, and with it is removed the greater part of the inorganic materials which the fungus had collected. The ring may in the same spot remain in a better condition than the surrounding herbage for a second year, but after that it returns to its former condition, if indeed the exhausted state of the land will allow of even thus much.

The nitrogen of the fungus must not of course be left out in considering the manuring influence which this substance exerts upon the land, but I cannot help believing that it is to the inorganic elements that the effect is chiefly to be ascribed.

An experiment was made of spreading some fungi on the grass of the pasture where the rings occur; the letters in the form of which the fungi were arranged were clearly visible a month afterwards. If it be asked how comes the fungus to become such a collector of inorganic ingredients of a valuable nature, and why cannot the grass obtain for itself those substances which the soil can clearly furnish, I would say that I suppose this to be dependent on the peculiar structure and habits of these agarics. The cellular form of their vessels plainly enables them to abstract nourishment from the air at a prodigiously rapid rate; some of them, as the ordinary mushroom, growing to a large size in one night. And I can quite conceive it possible that the possession of this extraordinary power of organic assimilation would give a superior energy of vitality to the plant, and enable it more readily and quickly to obtain from the soil those mineral ingredients which its development requires. Another circumstance which would have a material influence in this particular is the quantity of water which circulates through such plants, and which would come to them loaded with the soluble substances of the soil.

The subject is a trifling one in itself, and more a matter of curiosity than of practical importance; but its notice may prove of service if it should deepen the conviction in the minds of agriculturists of the necessity and value of *in*organic manuring.

Here is a case of a luxuriant vegetation, caused chiefly, as I believe, although indirectly, by a mineral manure suited to the necessities of the particular crop which it has benefited.

To understand as we shall, it is to be hoped, one day the true system of inorganic manuring, we must be possessed of the requirements of all the different crops which are cultivated. Nothing short of this will remove from the science of chemistry the imputation which at present is too commonly cast upon it, of being comparatively valueless to the practical farmer.

Agricultural College, Cirencester,
Sept. 8th, 1846.

XXXVIII.—*Agriculture of North Wales.* By Thomas Rowlandson.

Prize Report.

Extent, Population, &c.

North Wales is divided into six counties, of which the following is the superficial extent according to the trigonometrical survey. The population is taken from the census of 1841 :—

COUNTY.	Number of Acres of Arable Land.	Number of Acres of Pasture Land.	Number of Acres of Woods and Waste.	TOTAL.	Population.
Anglesea . . .	Did not ascertain these particulars.			173,440	50,891
Carnarvon . .	100,000	148,160	100,000	348,160	81,093
Denbighshire . .	150,000	250,000	5,120	405,120	88,866
Flint	20,000	110,000	26,160	156,160	66,919
Merionethshire .	50,000	300,000	74,320	424,320	39,332
Montgomeryshire	60,000	180,000	296,960	536,960	69,219
	380,000	988,160	502,560	2,044,160	396,320

It thus appears, that although North Wales possesses nearly one third greater acreable extent than Lincolnshire, it exceeds that county very little in amount of population, whilst Wales has the further advantage of being an important mineral district, great numbers being employed in the copper, coal, iron, lead, zinc, slate, and manganese works, compared with another mineral district, Cornwall, its relative population is very small, being nearly three times the superficial extent of the latter named county, whilst it only outnumbers it by 55,041 inhabitants, which number will nearly approximate to persons dependent on the flannel, cotton, and other manufactures carried on in North Wales. From these comparisons the reader will be prepared to admit that the agricultural population of North Wales is amongst the lowest in proportion to its extent of any portion of England and Wales; this is mainly on account of the agriculture of North Wales being principally pastoral. I shall have occasion again to recur to the subject.

Varieties of Soil, &c.

It would be impossible, within the prescribed limits of a report, minutely to describe, according to their respective localities, the different varieties of soil existing in a country like North Wales, extending over a superficial area exceeding 2,000,000 acres, and embracing almost every description of known soil, whose surface has been broken and contorted by the upheaval, at intervals of immense distances of time from each other, of enormous masses of porphyry, clay, and transition slate, trap, grauwacke, lime, and

freestone, which, combined, form the base whereon rests the active soil on which the skill and industry of the husbandman have to be exercised; so broken is the surface of the country about to be described by the abrupt irruption and intermixture of masses of rocks, of varied chemical and geological character, in the vicinity of each other, that to attempt to classify the soils by either the geological or chemical data of the rocks on which the active soil is superimposed is wholly impossible. At the onset, therefore, the reporter craves the indulgence of the reader for what might otherwise be considered a want of method in the arrangement of this part of the subject. It was his original intention to have classified the same under either a geological or chemical type, and, when possible, under both; a most minute and careful examination of the country has convinced him that such an arrangement was not feasible. For the sake of perspicuity it is indispensable that some type or order should be pursued; in doing so I shall claim the privilege of grouping the soils under either a local or geological order, as may seem most meet for the purpose of giving a succinct and accurate description.

On entering Wales by the Chester road, the appearance that the country presents is that of a somewhat extended plain, with gentle undulations, gradually increasing into hills towards the western extremity, until the view is terminated by the increasing heights of the limestone hills of Flintshire, which are in some cases again overtopped by the still higher summits of the upper silurian mountains of Denbighshire, the latter forming the eastern boundary of the celebrated vale of Clwyd; a break occurs in the limestone series at Cyrn y Brain, this latter hill being classed amongst the caradoc sandstone series. Abutting to the south-east of Cyrn y Brain, the same limestone again crops out, forming a kind of crescent, the south-eastern horn of which abuts on the Chester and Holyhead road near Llangollen, when a break again takes place for a short space by the intervention of the upper silurian, in which at this place lies the bed of the Dee, and opposite the mail-coach route the limestone formation again appears, forming a narrow, but abrupt and somewhat elevated band, which passes by Chirk, and continues uninterruptedly in a southern direction to Llanymenach, about 10 miles from Welshpool, being, from Chirk to its southern extremity, coincident or nearly so with the borders of England; the southern, eastern, and north-eastern boundaries are formed by the river Dee and its estuary; taking the average length from Chirk in the south to Mold in the north, the same may be about 20 miles, and the width from Minera to the Dee about 10 miles. This tract contains the largest continuous extent of land of one particular soil of any part of North Wales; the whole of it lies on what are commonly known as the coal-measures, several most extensive

works, both of coal and iron, being situate within the limits of the boundaries described, and the general features of the country are similar to those surrounding other coal districts in various parts of England. I may however remark, that the soil is generally of a more free-working nature than is usually incumbent on the coal-measures. The most superficial observer will speedily discover that the soil on the left bank of the Dee (Wales) is of a much more friable nature than that on the right bank (Cheshire); this is attributable to the fact of a greater amount of silica (sand) being disseminated amongst the soil on the left bank, also in some instances to the additional ameliorating circumstance of calcareous matters being present, washed from the limestone hills which form its western boundary. Although the soil under consideration is called "stiff" in Wales, it is by no means to be understood as anything like so stiff as the strong clay lands of England; it is most properly classed by Mr. Davies in his report amongst strong loams. A few miles beyond Mold to the northward, this valley narrows very much until it reaches a little above Flint, when the land gradually rises, and continues to rise to the north-east extremity of Flintshire, forming from Mostyn to the point alluded to a narrow band of fertile land, rising somewhat suddenly from, and continuing parallel to, the borders of the estuary of the Dee towards its junction with the Irish Sea. A similar soil adjoins this, being a very narrow strip of land, which continues along the whole northern coast of Flintshire until it joins the vale of Clwyd, which latter rests upon the new red-sandstone, generally highly impregnated with peroxide of iron. The eastern side of the vale of Clwyd is bounded by a series of high hills of the upper silurian series, some of which, such as Morl Famma, can be seen at a very great distance in Lancashire; on the eastern side of these mountains abut the lime-rocks of Flintshire, as previously observed; the same lime-rocks crop out also in seven or eight places at the western base, intervening between the silurian formation and the sandstone of the vale; the western border of the vale is bounded by a series of limestone rocks extending from Cricor Mawr in the south to beyond Abergele in the north-west. The soil of the vale of Clwyd is somewhat similar to that described as stretching from Chirk to Mold, and from the limestone hills of the west to the banks of the Dee on the east, which district, for the sake of perspicuity, I shall in future term the vale of Wrexham, which occupies the greater part of Flintshire and a large section of the southern portion of Denbighshire. The vale of Clwyd differs from the vale of Wrexham in its land not being quite so adhesive, mainly from an abundance of peroxide of iron in the soil. The upper part of the vale of Clwyd, commencing a little above

Ruthin and proceeding southward until we come to the rise at Cricor Mawr, gradually becomes more friable by an increased intermixture of sand, changing from the lower part of the vale to the highest from a stiff loam through all the gradations of sandy loam till the same merges into a deep red coloured sand, held together by a small amount of aluminous and vegetable matter. Following the course of the Clwyd from Ruthin to the northward, the vale gradually expands, and the soil becomes stiffer and continues as we proceed to the northward to indicate the presence in increased proportion of aluminous matter until we arrive at the northern extremity of the vale, which is bounded by the Irish Sea, at some distance from whose margin the soil assumes the well known appearance of warp-land.

The fertility of the vale of Clwyd has been proverbial; and perhaps no better opportunity could be taken to examine the reasons why the vale of Clwyd, which extends to the westward of the Clwydian range, should be found and is esteemed so much more fertile than the vale of Wrexham, which lies to the east of the same range. It has been previously remarked that the soil of the vale on the western side of the Clwydian range is more friable than that on the eastern, in consequence of which it is much more permeable to moisture, which is speedily absorbed by the red-sandstone underneath, or carried away by the various fissures of the subjacent rock; on the other hand, on the eastern side the soil is extremely thick, and somewhat impermeable. The difference of temperature caused by the absorption of heat by the evaporation of so much more moisture in proportion to its extent, combined with the prejudicial influence of a redundancy of moisture in the soil, will, in the absence of a perfect system of drainage, account materially for the western exceeding the eastern side of the range in fertility. In addition to the preceding, there are other causes; the vale of Clwyd is bounded on every side except the north by hills, most of which are of considerable elevation, whilst the vale of Wrexham is only sheltered from the most genial wind that blows—the western: the cold cutting north-eastern winds so prejudicial to vegetation, especially in spring, are scarcely ever felt in the vale of Clwyd; the direct north wind seldom blows, and when it does, though it may be boisterous, the temperature is much ameliorated by passing over the uninterrupted expanse of the Northern and Irish Seas.

On the limestone hills, which are intermixed and surround the two vales just described, it may be stated that the short ridge extending between Llangollen and Cyrn y Brain are precipitous and almost bare of soil from the base to the summit; the grass growing on it is analogous to that grown on other limestone districts, and is well adapted to the rearing of South-down sheep,

the herbage being short but sweet; the surrounding upper silurian hills which stretch from Llangollen to Corwen are also well adapted to the same purpose. I shall have occasion to return to this subject hereafter. The extensive band of limestone which stretches from Cyrin y Brain to the north part of Flintshire is, in the lower or level part, covered with a soil similar to that described as constituting the vale of Wrexham; as its altitude increases, the soil becomes thinner, poorer, and approximates in quality that which covers the adjacent more lofty silurian hills, passing gradually into a scanty stony soil, broken by protruding rocks, the herbage plentifully intermixed with gorse, heather, and the usual mountain plants, and only adapted for the browsing of mountain-sheep. Stretching from west to east, in the Clwydian range, are several valleys of considerable fertility; the soil somewhat similar, but not equal to that of the vale of Wrexham, and frequently intermixed with pebbles; between the arable land of these transverse valleys and the mountain sheep-walks alluded to there is generally planted a zone of timber, usually larch, which adds much to the scenic beauty, and greatly to the warmth and comfort of the vales: an example deserving of more extended adoption in other parts of Wales, combining as it does the useful, profitable, and ornamental; similar remarks apply to the soils superimposed on the narrow strip of limestone which bounds the western side of the vale of Clwyd, beyond which, to the south-west, an extensive tract of upland moor stretches, included in a line drawn from the Conway river to Bettws y Coed, then by a line nearly due south from Bettws y Coed to Yspetty Evan, from which point it takes an eastern direction, crossing the Holyhead road close to Cerrig y Druidion, and continues this course to the rise of the Clwyd, which has its source almost at the junction of the great protozoic range and the upper silurian of Denbighshire; from the source of the Clwyd the boundary-line turns to the southward, and continues in that direction until it meets the Holyhead road about 2 miles to the west of Corwen, from which point it takes a zig-zag direction to Llansaintfraid on the Ceriog and Chirk, the eastern boundary being formed by the disconnected limestone hills extending to Cerrig y Brain and Cricor Mawr, to the north of which it is formed by the limestone ridge of the western border of the vale of Clwyd, and extends as far as the Ormsheads and Conway river. The above described tract of country forms the upper silurian of Denbighshire; it is noticed in Mr. Davis's report as the Hiraethog range, who alludes to it in the following manner:—

"The latter wing" (the Hiraethog range or western side of the valley of the Clwyd, in contradistinction to the eastern side or Clwydian range) "commences in the argillaceous hills above

Derwen: and from that to Eglws Vach, on the river Conway, its north-western extremity, it forms one of the most extensive and dreary wastes in the principality, being from 25 to 30 miles in length, and of various breadths from 5 to 10 miles. It chiefly consists of shale, besides grey mountain rock, or semi-indurated whin, and flags for flooring and tombstones. . . . . On the western side this argillaceous range is intersected by narrow veins of grey limestone, which run transversely to the direction of the range, in their usual course from north-east to south-west.* Heath or ling is the general covering of this vast tract. The hollows and flats abound with good depths of excellent peat for fuel, &c."

The Hiraethog range of Mr. Davis coincides with the line which I have previously described as bounding the Denbighshire upper silurian formation; but the line drawn in this paper includes a small tract of country which Mr. Davis's does not, viz., the country included in a line drawn from Corwen to Cricor Mawr, by the base of Cyrin y Brain to Chirk, thence to Llansaintfraid on the Ceriog by Moel Ferna to Corwen. The small section of hilly country just described possesses considerably greater capabilities than that described by Mr. Davis as the Hiraethog range, the vale through which the mail-coach runs from Llangollen† to Corwen in many places being highly fertile; and so also on the parallel and transverse valleys included in this latter district, which gradually becomes less luxuriant as we approach Cricor Mawr, Corwen, and Moel Ferna. Some of the hills are cultivated to their summits, whilst on such hills as cannot profitably be brought into cultivation, either from the scantiness of the soil or the number and size of the stones, the herbage is of a better description than that on the Hiraethog range; it is remarkable also for the general absence of peat. There are certainly many spots where it would be advantageous to remove the heath by grubbing and burning; the labour and capital employed in such an undertaking would be profitably invested. I may allude, at a future part of this paper, to the great difference in the quality of the soil of the southern portion of the Denbigh upper silurian formation and the Hiraethog or northern portion. The Hiraethog range still deserves the description given of it by Mr. Davis; nevertheless there are large portions of the same now in a complete state of nature, on which capital and industry could be most profitably applied. The luxuriant growth of the heath, fern, and foxglove in many places, are clear indications of the riches that are in store for the first adventurer who shall attempt to break up this almost desert waste. I saw in some places patches of deep

* Probably identical with the Glyn Diffwys, Rhiwlas, and Bala limestones, to be hereafter alluded to.

† The Vale of Llangollen is included in this district.

hazel loam which had been broken up from the wild state during the last two years, covered with oats and grass of the best description, offering ample encouragement to proceed further; on the other hand, there are large tracts of land covered with only two or three inches of active soil, yielding a stunted herbage of caricii juncii, agrostis, &c., much intermixed with dwarf-heath, the subsoil consisting of a mixture of dirty-yellow coloured clay and gravel, highly retentive of moisture; that a large extent of the Hiraethog range consists of this, intermixed with peat, must be admitted, The question of the propriety of attempting the respective cultivation of each I shall leave to another period. Portions of the range must be held as an exception to the general rule, such as the vale of Llanrwst, Conway,* and other intersecting vales, which, though they may not possess the high fertility of the vales of Wrexham and Clwyd, consist of first-rate soils. If we cut off that portion of Caernarvonshire known as the promontory of Lleyn, which I did not visit, but which Mr. Davis describes as being similar to the Isle of Anglesea, and draw a line from Caernarvonshire to the mouth of the Dyffi, continuing the same from the mouth of the Dyffi to Mallwyd, from Mallwyd to Conway, and Conway to Caernarvon, we shall have presented to us a section of the country of the form of a rhombus. In this latter are situate the highest peaks in Wales; viz., Snowdon, Cader Idris, Carwdd, Llewellyn, C. Dafydd, Penman Maur, &c. &c., whilst its eastern limits pass over the bases of the Arenigs, Arran Mowddy, &c. &c., with the exception of a narrow interval on the shores of the Menai Straits and in the vicinity of Bangor, where there is a small outer-cropping of limestone and the coal measures, the whole of this district is composed of the protozoic rocks, frequently thrown up in the most abrupt and precipitous manner. Very little land of good quality is to be found in the district I am now describing; it is only to be seen in the neighbourhood of Caernarvon, Bangor, the western side of the Conway vale, the vale of Festiniog, the banks of the Mau, the Unwin, and the Dyffi, together with the narrow vales on the borders of minor streams, too numerous and unimportant to be particularly described. The greater part of the best soils in this district should only be termed second-rate quality. The principal portion of the northern part of the division is covered with barren mountain, principally consisting of slate, but frequently intermixed with a siliceous grauwacke, the soil formed from the disintegration of which is of a cold retentive nature, generally of a blue or bluish-grey colour, which rarely presents itself at the surface, except when it is seen in the act of forming, being the diluvian of

* The eastern side of the Vale of Conway is on the upper silurian formation: the western portion is on the protozoic.

mountain torrents, the great mass of which is covered by a stratum of peat, from a few inches to several feet in depth. In some places, as between Snowdon and Festiniog, there are several hills of not quite so alpine a character, the principal summits being round-backed hills, covered with the ordinary heath-plants and grasses, generally growing on a thin peaty soil, with a subsoil either of the dirty-yellow colour, noticed in the Hiraethog range, or blue clay; sometimes the subsoil is an intermixture of both. A description of the appearance presented by the country along the Holyhead coach-road, after leaving the Pennant slate-quarries and proceeding to Capel Curig, will give a general idea of the soils existing in this alpine district, which may be said to extend from Penman Maur, in the north, to the range of hills in which are the Festiniog slate-quarries, in the south. On leaving the Pennant quarries the country, which had previously been of a mixed nature, viz., mountainous, with intervening vales of moderate extent, consisting of the best description of stiff loams, begins now to assume a decided alpine character. On the right for some miles the slate mountains start up at a very high angle, in some places almost perpendicular, with scarcely a vestige of vegetation; on the left an immense slate, intermixed with grauwacke rocks, tremendous loose blocks of which latter are plentifully distributed along the sides, from the base to the summits, threatening the traveller with destruction at every step,—the vale now gradually narrows to a width in no place exceeding three hundred yards; the soil consisting of peat about a foot in depth, much mixed with the earthy matters carried down by floods from the surrounding mountains. The fields are intersected at long intervals with drains, which in some places are contrived to assist in catchwork irrigation, the latter executed in a most clumsy manner. As the traveller proceeds the valley appears closed up, a high slate mountain directly facing him. At a somewhat sudden turn of the road the outlet makes its appearance, being a narrow rocky path formed with great labour, and a rude bridge, over which the traveller crosses from the right bank to the left of the small river which issues from lake Ogwen; the road still for some distance on each side presenting nothing but rocks, until he arrives at Lake Ogwen, on each shore of which the desolate appearance already described continues, till the approach to the head of the lake, where the surface assumes the appearance of low round-backed hills, containing considerable projecting rocks and boulder stones, a deep peat-moss in each hollow, gradually lessening in depth until it assumes the ordinary peaty moory soil, more than once alluded to previously, and to which I shall have other occasions to recur. The scene, as now described, continues to Capel Curig, where the hills again assume an alpine character (a great part of

Snowdon being here seen, which closes the vista to the southward), leaving only a very narrow margin of arable land, but of good quality. The sides of the hills are now however extensively, and especially on the Gwydir estate, most tastefully planted with larch, beech, and birch; this continues to the junction of the protozoic with the upper silurian range, about midway between Bettwys y Coed and Pentre Veolas. The preceding outline will, I trust, give the reader a general outline of the appearance of the hills and glens of the extensive tract of country which may emphatically be called the alpine slate district of North Wales. The district south of that just described, though not abounding with as numerous high peaks as the one previously noticed, yet the average surface of the soil is perhaps of much higher altitude than the alpine district already delineated,* being bounded on the east by the towering and majestic summits of the Arenigs and Arran Mowddy, and traversed in a north and south direction by two ranges of high hills which intervene between the Arenigs and Cardigan bay, in the south Cader Idris, and the adjacent hills, which may be called her satellites, occupy also a large space of the county now under notice. Very little land in this district is found under tillage; it principally lies in the vicinity of the sea-coast, the banks of the Mau, the Unwin, and the Dyffi. A large extent of the surface of this district is occupied by peat-mosses of all forms and varied extent, many of which are capable of being brought into cultivation at a slight expense, the farmers are principally engaged in grazing and rearing black cattle and sheep, the predominating stock being black cattle.

To the east of the last described district, but on the same geological formation, the protozoic rocks stretch from the Arenig chain to the limestone on the borders of England, which forms the eastern boundary, being co-terminous on the northern boundary with the upper silurian system of Denbighshire, from Yspetty Evan to Chirk; its southern boundary is formed by a most tortuous line drawn through Mallwyd, Carrig-y-Big, Llanfillan, Pen y Craig, to the limestone range at Llanymenach. This portion of the protozoic formation of North Wales is deserving of especial attention, as in addition to the porphyries, slates, and grauwackes found in other districts, there exist also several

* The mountains do not appear to the spectator of so great an altitude as in the first described district, in consequence of his frequently unconsciously standing on land as high as some of the minor summits in Caernarvonshire, the inhabitants being a gradual and constant elevation towards the centre of the district, whether the traveller proceeds from Harlech, Dolgelly, or the Vale of Festiniog. Nannau, the residence of Sir Robert Vaughan, between Dolgelly and Bala, is said to be the highest gentleman's residence in Great Britain; and Bala Lake is said to be 1000 feet perpendicular above the level of the sea.

bands of limestone; and is further remarkable for the south-eastern portion of the district, possessing a soil similar to the upper silurian formation in the neighbourhood of Welchpool. A low set of moors extend from Yspetty Evan to Arenig Bach, crossing the Glyn Diffws and Rhiwlas limestones, after which they join the Berwin hills at their north-eastern extremity. On the road from Festiniog to Bala there is a considerable quantity of reclaimable peat vales, which gradually pass into rich arable and pasture lands in the vicinity of Bala and Rhiwlas; soils of a similar description, viz., a good hazel loam, extend along each bank of the Dee from Rhiwlas to Corwen. The level portion of the transverse valleys which open on to the Dee are of a similar character: passing over the Dee at Bala, we arrive at the centre of the Berwin range.

Mr. Davis states in his report, that the Berwin range takes its rise near Chirk Castle, in Denbighshire, and continues to Cader Idris. He further states, that "The geometrical length of this range is 54 miles, and a straight line drawn from point to point would measure 49 miles;" further, that "the north-eastern extremity of this argillaceous range is abutted with the Vron and Bronigarth limeworks." The north-eastern portion of this range has already been described amongst the Denbighshire upper silurian hills, which stretch from Llansaintfraid, on the Ceriog, to Llangollen, and from Chirk to Moel Ferna, near Corwen, where the range joins the protozoic formation. The country round the south-eastern portion of this range, from Arran Mowddy to Cader Idris, has been described in the account of the district west of the Arenigs. Mr. Davis writes of the Berwins, that "the surface-produce of this range is, first, fern; and whin or gorse upon the lower and drier outskirts; heath upon the loftier summits of argillaceous schistus rooted upon shallow peat upon clay or rammel; rushes and varieties of mosses, and alpine aquatic plants on the humid slopes and hollows, upon various depths of peat." I may briefly state in addition, that I passed over the range about its centre, viz., from Bala to Llangynnog, the total distance of which is about 12 miles, the last 10 of which are through or over the Berwin mountains, and I can vouch for the accuracy of the description given by Mr. Davis, so far as the range extends from Arran Mowddy to Moel Ferna, and from the river Dee to Llangynnog—a tract of country about 20 miles in length by about 9 in width, barren, cheerless, and almost totally irreclaimable at a profit, if we except some formations of peat. Proceeding from Bala, and about two miles before arriving at Llangynnog, we come to the summit of a mountain-pass, which gradually descends to the latter place. In the course of the descent the traveller has the opportunity of admiring one of the most

beautifully picturesque valleys which is to be seen in the country, and which literally lies under his feet; it is embosomed on every side by high and precipitous mountains, so much so that it is almost impossible for the spectator, from his high position, to imagine the place for ingress or regress.* On descending the mountain I found that the vale which looked so beautiful was far from having its capabilities fully developed: the meadows and pastures abounded with dwarf aquatic grasses, the soil being composed of peat mixed with finely divided argillaceous and siliceous matters—one of the most fruitful soils under proper management.

There exists, to the south-east of the Berwin range, and still situate on the protozoic rocks, an undescribed portion of fertile country. It is bounded on the north and west by a line drawn from Hirnant, through Llangynnog by Craig y Glyn to Gyrn Moelfre, beyond which, a little to the eastward, it is bounded by the limestone rocks extending on the eastern border of Wales from Llansaintfraid to Llanymenach. Its southern boundary is nearly co-terminous with the river Vyrnwy. The rivers Tanat and Avon Caen run through the district. The soil is generally a deep rich hazel loam, dry, and adapted to every species of husbandry. The country I am now describing is covered with gentle undulating hills, with intervening valleys of great pastoral, sometimes intermixed with sylvan, beauty. My principal reason for separating the sole consideration of the soil of the protozoic rocks existing on the eastern from that on the western side of the Arenigs, was to point out the fertile tract now under description as differing wholly in appearance from anything to be found elsewhere on the protozoic rocks. The appearance and constituents of the soil would suggest that it was formed by the decomposition of the upper silurian rocks which lay to the south of the Vyrnwy,† and which on the eastward closely approaches Llanfillan. The country in the vicinity of Welchpool (the upper silurian) possesses in part the characteristics of the country described as situated between the Vyrnwy and the Tanat. It gradually becomes less undulating, and eventually assumes the appearance, as it

* It is said that Dr. Johnson took the idea of the happy valley in 'Rasselas' from the Vale of Clwyd. The Vale of Llangynnog, as viewed from the top of the mountain descent, is much more appropriate.

† It is probable that the soil has been formed by the decomposition of the upper silurian rocks, and deposited in its present situation whilst beneath the sea and below the level of the neighbouring upper silurian formation, which extends from the Vyrnwy to Welchpool. From similar indications I conjecture that the Hiraethog range has been thrown up at two or more intervals, which would in some degree account for the different quality of the soil in the northern part, which is so barren, from the southern portion, which joins the Berwin range at Llangollen, the soil surrounding the latter place being pretty good.

approaches the Severn, of a rich level plain; soil argillaceous, and somewhat stiff, well adapted to the growth of beans and wheat. Some luxuriant crops of the former I had an opportunity of inspecting. The main portion of the stiffest land was occupied in pasture. The undescribed part of North Wales, situate to the east of the Severn, principally rests on the Severn flagstones, the soil generally speaking of an alluvial nature, but in some few instances, from the outcropping strata, becomes light and sandy. I believe I have now given a more or less descriptive account of the characteristics of the various soils of the several districts situate on the mainland of North Wales, with one exception, viz., the soil superimposed on the narrow band of limestone which stretches from Llanymenach to Chirk. The soil under consideration is a deep red loam, somewhat stiff, and highly impregnated with the peroxide of iron. It has no corresponding equivalent in the soil of any other part of Wales, if we except some parts in the vale of Clwyd. It is very fertile, and peculiarly well adapted to the alternate husbandry.

I am afraid the preceding description of the soils of North Wales will scarcely be understood without the aid of a good map. With such, I hope, it will possess sufficient perspicuity.

Anglesea.

I have separated the consideration of the soils of the Isle of Anglesea from that of the mainland in consequence of its surface possessing most of the physical varieties of appearance described as existing on the mainland. To have intermixed an account of the soils of so small a portion of the country as Anglesea with the more extensive tracts on the mainland, would have only led to confusion in the description of portions of the country snfficiently difficult to describe of themselves.

The north-eastern portion of the Island of Anglesea is situate on the carboniferous limestone, intermixed with silurian rocks, composed of a green argillaceous substance mixed with quartz—the latter interstratified in the rock precisely similar to the enamel in the teeth of graminivorous animals. This is shown in the clearest manner on the shores of the Menai, close to the landing-place at the foot of the Menai suspension bridge, where, by the united effects of the atmosphere and spray, the argillaceous matter has become decomposed, forming a fine brown-coloured loam of excellent quality. The greater part of the soil along the Menai Straits is formed by the decomposition of these rocks, leaving large fissures, approaching in places to rents, in the quartzy matter. In this state the rock has the appearance of solidified billows of scoria or lava. Portions of the rock thus disintegrated become

gradually undermined by the action of moisture and the atmosphere, detach themselves from the main rock, and form boulder-stones so frequently found along the coast of the Menai. In other cases large intervals have been swept away from similar causes, leaving projecting pieces of quartzose rock in the fields. The circumjacent soil being of excellent quality, these often repeated obstructions have not prevented the husbandman from the use of the plough. About three miles from the bridge are the coal-measures, several pits of which are worked in the centre of the marsh, which extends from Newburgh, in the south-west, to the centre of the island. The coal-measures extend as far as the sea on the north-east. Some attempts have been made to reclaim this extensive marsh, which is composed of the stiffest clay soil which I witnessed throughout North Wales, and under judicious management would form one of the richest grazing-grounds in the kingdom. The abundance of stock feeding thereon, and in good condition, notwithstanding more than three-fourths of the surface was covered with rushes, amply testified to its natural capabilities; and I have no hesitation in declaring that with proper care and management it might be made to rival the celebrated Lincolnshire salt-marshes. To the west of the marsh the limestone formation crops out, forming a gentle undulating country that covers a moderate extent of the island, having a tolerably deep fertile turnip soil in the hollows, which gradually thins out, and becomes much intermixed with gravel and stones towards the tops of the hills. A considerable portion of the southern coast is sandy. The northern part of the island possesses some good pasture-hills, but very bleak—some of the pastures, especially in the neighbourhood of Amlwch, being deteriorated, and in places entirely destroyed, by the adjacent copper-works. From Mona, near the centre of the island, to Holyhead, the general character of the country is that of a second-rate grazing district, adapted to rearing and maintaining store cattle, much intermixed with projecting rocks and stones; the soil thin, composed of vegetable matter intermixed with a loose brown or ochreous coloured rubble; the country bleak from the absence of timber; the formations of peat not plentiful, and rendered valuable by the scarcity of fuel. There are a few large farms in the island, with excellent modern-built homesteads and offices, on which the course of cropping is superior to that seen in general throughout North Wales, even on the best farms. That part of Anglesea adjoining the Menai Straits, from its verdant appearance (and the same may be said of the opposite or Caernarvon side), may compete with the most beautiful portions of the sister kingdom for the title of "the Emerald Isle" being applied to it. In no place throughout the United Kingdom did I ever witness herbage of so beautiful an appearance.

The ordinary Modes of Farming, and Courses of Cropping.

The first thing that strikes the inquirer on entering Wales for agricultural and statistical information, is, that it is essentially a pastoral district, tillage being in most cases made subservient to grazing. There are many farmers in North Wales who do not grow one single ounce of grain: nay, I was assured that some did not even cultivate a potato-patch. This latter circumstance appeared to me so surprising that I made most minute inquiries on the subject; and from a close examination of the grounds about, and also to a considerable distance from, the dwellings of several farmers in the alpine slate district of Caernarvonshire, I am bound to give credence to my informants. In such cases the farmer, and what few assistants he may have, obtain their supplies of oatmeal from the nearest miller or town. Such farms are almost solely mountain sheep-farms of great extent. A few black cattle may be grazed in addition, such being desirable; a little milk, butter, or cheese being an agreeable addition to vary the modes in which oatmeal is usually used as an article of diet. Black cattle are only kept when some deep, wet, and rushy soil, generally peat, exists in the hollows, which yields a crop of indifferent hay, and affords the only winter fodder for the cattle. If any bedding is given, it consists of rushes and fern. The miserable manure such provender and bedding must produce can easily be conceived by the farmer who spends hundreds per annum for oil-cake in order to enrich his manure heap. As if it was not already sufficiently poor, the manure, when heaved out of doors, is thrown into an irregular heap; and as the offices are usually placed on the side of a declivity, it not unfrequently happens—in fact, oftener so than otherwise—that the place selected is a hollow formed in the bed of some small watercourse, which might persuade an observer that the object was to bleach the heap by the joint action of the atmosphere and water. After undergoing the process stated, it is eventually spread in spring on the meadows by way of top-dressing, if such a term as meadow is applicable to places, the hay from which, when stacked, is nearly as black as a bean-stack. These, of course, are extreme cases, but such things exist, and as a faithful chronicler I feel it my duty to describe them. With respect to the vale of Clwyd, I will give an extract from a letter favoured me by a gentleman resident at Ruthin; the modes of farming which it describes, so far as tillage is concerned, accord with my own observations and the information received from others:—

"In the fertile vale of Clwyd I consider there exist two descriptions of occupation, one ranging from 150 to 300 acres, the other from 60 to 150. The former tenantry are a respectable class of people, generally

possessing capital sufficient to cultivate their lands: nevertheless the difficulty of meeting constant expenses frequently induces some of them to forego their wonted course to suit emergencies.

"The smaller sized farms are often occupied by those whose means are not equal to their take, and who therefore are always in difficulties. Those who are more able are compelled to hurry their lands by too frequent cropping to meet their calls. There are of course exceptions; for in many instances, where farms are got into a good course of management, the occupiers prosper. Rents in Wales range considerably higher than those of lands in England of similar fertility. Although the approach from these farms to good markets is often tedious and difficult, yet generally in this district the rents are not very high in comparison with other parts of Wales; for this part is chiefly the property of those who are influential and benevolent. Tithes and taxes are our most serious considerations. Rents range from 25*s.* to 40*s.* upon the best soils. I believe the tithes and taxes are about 12*s.* to 13*s.* and 16*s.* to 18*s.* per acre on the best soils. At the south end of the vale the soil varies often from gravelly to a reddish but kind description of soil, sometimes approaching to clay. Towards the centre of the vale, or a little north of Denbigh, the soil is for a few miles of an inferior description. or, if I may so describe it, thin and poor. From thence towards the sea it gradually approaches a strong clay or marshy soil, upon which much wheat and beans are grown. On this strong land the tithe (commuted) averages about 8*s.* to 9*s.* per acre, and the former from 4*s.* to 6*s.* per acre.

"The usual course of cultivation is the six-course shift, viz., wheat, barley, turnips, barley, with clover lying for two years; but more north, wheat and beans are the prevailing crops. In the wheat-growing districts from 4 to 5 quarters per acre are good average crops; but to the southward 3 quarters per acre can only be depended on. Barley, in the best soils, from 5 to 6 quarters; oats from 5 to 6 quarters. We are bounded on the west by a poorer sort of soil, growing wheat 1½ to 2 quarters per acre, barley 2½ to 3 quarters ditto, oats 2½ to 3½ quarters ditto, extending to the uninclosed mountains upon which sheep are reared. The soil here is generally very poor, and the elevation high. The occupiers of the inclosed farms, averaging about 60 acres, probably at 12*s.* per acre, are generally a hard-working class of men, who endeavour, by unceasing labour and economical mode of living, to provide for their families. They are seldom enabled to further their prosperity by education, but are silent or satisfied, and deserve the sympathy of those who acquire wealth by less labour and easier occupations."

In the course noticed by my Ruthin correspondent, I must remind the reader that at the commencement of each course it is lea that is broken up. The turnips are always drawn, and in many places potatoes take the place of turnips in the rotation. After the land is laid down to grass two or three years, it is again broken up for wheat or other grain crop, according to the quality of the land. The above is a fair description of the system of tillage pursued throughout the vales of Clwyd and Wrexham. In

the vales of secondary quality, as regards fertility—such as the principal one that runs from the commencement of the Berwyn range near Llangollen, through Corwen and Bala to Dolgelly, together with the adjoining transverse valleys, and also the intermediate ones between the various other minor ranges of hills throughout the district—the usual practice is to take wheat on the lea where the land is strong enough; if not, oats. I was informed that barley is sometimes taken on the lea. After wheat or oats, according to the quality of the land, is taken a crop of potatoes manured, succeeded by wheat or oats laid down with grass seeds; hay one or two years; pasture two years more, again to be broken up and followed by the usual routine of crops already described. Turnips sometimes replace the potatoes in this rotation: turnips are gaining ground. The question of their relative merits rests mainly on the circumstance whether the farmer devotes most of his attention to sheep in conjunction with cattle, or pigs with cattle, maintaining only a few sheep. A more common course than that described is wheat on the lea, oats, potatoes or turnips, but generally turnips eastward of Corwen (northward of which place potatoes in general are grown, and in a greater ratio as we proceed in a western direction), oats, again oats, then grass from three to five years—the length of the rotation and description of crop depending upon the staple of the land and the pressing wants of the farmer. With respect to green crops, I may observe that turnip husbandry generally ceases when scourging crops commence. The course I have just described is generally found on farms of from 40 to 120 acres each in extent, together with a run of sheep on the mountains of from 100 to 1000 head, the rental of which is valued at from 1*s.* to 2*s.* per head, according to the quality of the grazing.

In the remoter districts of North Wales the plan pursued is well described by an esteemed correspondent resident at Dolgelly. He is probably a little too satirical in his observations with respect to the extreme obstinacy with which the people persist in the observance of old usages, and their aversion to the adoption of new plans. For the general accuracy of the remarks I can vouch; and in consequence of it (the Letter) containing several minute details which would possibly escape the notice of the general observer, the Letter is of peculiar value; I now submit a very copious extract from it. I may previously remark, that the numbers have reference to samples of rocks and soils which I desired to be collected for the purpose of analysis; they arrived too late to be made use of for this paper; they were selected in the neighbourhood of Cader Idris:—

"The samples are taken from land which has never been ploughed or manured further than the usual droppings of cattle and sheep. Nos. 1

and 2 are from land situated about 700 feet above the level of the sea. I have marked soils, subsoils, and stone, with the same numbers. The soil I think you will find strongly impregnated with iron and sulphur, which shows what benefit lime would be if applied in that neighbourhood; but the farmers are too poor to pay for lime. It is only in such situations as this where you will find the lazy-bed fashion of planting potatoes, and that is not followed to the extent it was about seven years back. I should say that at present about one-eighth are planted in beds, so as to have them ripe about a fortnight earlier, and the other seven-eighths are drilled. Many of the farmers will keep the same ground in potatoes two or three years in succession; the same with oats, manuring the second crop, but without any to the first and third, which will do little more than give them the amount of seed sown, with a very small quantity of straw; after which it (the soil) is left to take its chance. I forgot to name, that after taking three crops of potatoes, one after the other, they will attempt to grow a crop of wheat, which will not make a sufficient return to pay for seed, labour, rent, &c., the quality being very inferior; in fact, I have never seen any but has been injured by mildew and rust. Sometimes they will try barley, which answers a great deal better than wheat; but let them grow which they may, they leave the land in a most filthy and slovenly state, to take its chance afterwards. The rents in such localities are principally derived from sheep and black cattle, which are inferior to those of Anglesea; the sheep are of the small mountain-breed, and are kept until they are four years old, when they are sold off to the drovers, who take them to the neighbourhood of London; the prices the drovers give for them here are, wethers, 8*s*. 6*d*. to 9*s*., ewes 6*s*. to 7*s*. 6*d*.: they make the finest flavoured mutton in Wales.*

"The cattle are generally kept until they are three or four years old, when they are sold to drovers, who take them to Barnet fair, &c., to be disposed of to the Norfolk, Essex, &c. graziers, who feed them for the London market. The drovers are generally men of the immediate neighbourhood, who mostly buy partly on credit, paying at the time of delivery about one-fourth or half the amount of sale, by which custom the farmers are often great losers. If the drover does not get the price in England that he expects, he will contrive to get 5*s*. per head or so allowed him at the time of settlement; and very often false statements are made to get such allowances. They often decamp with the produce of the sale, or become bankrupts, whereby the poor breeder will only get a few shillings or nothing in the pound, the loss often falling eventually on the landlord, the tenant being too poor to meet it. The prices the black cattle range at in the fairs here are, 3-years old, from 6*l*. to 9*l*.; 4-years old, 8*l*. to 12*l*. or 13*l*. for very prime. About three-fourths of the lots will consist of oxen, and the other one-fourth heifers; the heifers are seldom spayed. The breed must deteriorate in quality, as the farmers mostly keep the worst calf to rear for their bull. On the small

* A considerable quantity of mountain thyme grows in the pastures alluded to, which is known to give an exquisite flavour to both mutton and venison.

farms the tenants generally rear from 2 to 3 pigs, which when fat will average from 15 to 25 score weight, one of which, always the worst, they keep for their own use, and the others they sell to drovers at about 3*d.* per pound alive.* From this county (Merionethshire) they are all driven down to Shrewsbury, Bridgenorth, Wolverhampton, and neighbourhood. Good butter and small skim-milk cheese are made. No. 3 samples are from land situated about 600 feet above the level of the sea. Rents mostly made out of sheep, cattle, pigs, and butter, which are disposed of as before mentioned. The system of cropping is generally oats after one ploughing (no manure of any kind); 2nd year, potatoes and weeds; they consider weeding a waste of time and do not calculate the nourishment taken from the soil to support such weeds. After the potato-plant appears above ground they mostly give a slight top-dressing of lime; 3rd year, wheat; 4th, barley; very seldom laid down with good grass seeds or clovers. Some crop as follows: 1st year, oats; 2nd, potatoes; 3rd, barley, laid down with grass-seeds and clovers, or oats, potatoes, barley, oats, and then left to chance. No. 4, as well as the preceding samples, is strongly impregnated with iron and iron pyrites; the stone, which is not above 18 to 24 inches below the surface, is very rich in metal, yielding on an average 55 per cent.; the deposit of ore in this neighbourhood is immense: it extends over some thousands of acres, and its thickness is not known; the style of farming same as the first named. No. 5 sample is from land about 10 to 12 feet above the level of the sea; the system of cropping is oats first, manured with night-soil;† 2nd year, potatoes, manured with farm-yard manure, top-dressed with lime when the leaves appear above ground; little attention paid to weeding; sometimes in the corner of a potato-field you may find a small patch of swedes or turnips, but very rarely; 3rd year, wheat; 4th year, barley, sometimes laid down with clovers, rye-grass, &c.; no cheese made in this district; the cream is made into butter; skim-milk disposed of in Dolgellan at 2*d.* per quart, the butter at from 10*d.* to 1*s.* per lb.; live stock sold as in other parts of the country; this is in the immediate neighbourhood of Dolgellan. In the neighbourhood of Towyn the farming is of a better description; farms larger, soil richer, although they are more or less impregnated with iron, manganese, &c.; the subsoils are principally intermixed with shale, gravel, or decomposed slate, resting upon a blue clay, same as the one sent in No. 3 sample; the rocks are varied: generally slate, iron, with veins of manganese and greenstone; the cropping is first year turnips or potatoes; 2nd year, wheat; 3rd year, if potatoes the first year, the third year will be turnips, or if turnips the first year, the third year will be potatoes; 4th year, wheat; 5th year, barley, laid down with clovers and grass-seeds; they generally lime well the first year; live stock sold as in other parts of the country. Llanegrin, farms not so large; system nearly the same. Llwyngwil, system of farming same as Towyn; but in this immediate

* It may be noticed here that the custom obtains in many parts of North Wales, of putting the live grunter in the scales, and deducing the nett dead weight therefrom, at which the drovers and butchers in that country are exceedingly accurate.

† Being near Dolgelly.

neighbourhood a great many of the Galloway breed of cattle are reared; also a good many crosses from the Galloways; the stock is mostly sold at the fairs. Some of the farms in the three last-named places will feed from 20 to 40 pigs, weighing on an average 20 score each. Duffryn: soil of a sandy and peaty nature, resting on a gravelly subsoil upon blue clay; stones principally greenstone and slate. Cropping: first, oats; 2nd year, potatoes, very seldom swedes; in the drills they dibble two rows of beans; across the top they are in distance about 4 inches from each other, lengthways about 12 inches, so that every potato set is between 4 bean sets; they answer well; 3rd crop, wheat; 4th barley, sometimes laid down. Good fat pigs are sent from this neighbourhood. Dolgellan is their fair.

'*Cheese.*—In the smallest farms of the county cheese is made (in fact, where they only keep from one to three cows); you will often meet with them of no greater weight than 3 lbs.; they are principally skim-milk; but on the large farms they make a certain quantity for home consumption of skim-milk, and what they make to sell is made from one meal's milk skimmed, and the other meal's milk with the cream in it, which makes pretty middling sort of stuff; it generally goes to Chester, Wolverhampton, &c.; price about 4*d.* to 4½*d.* per lb.

'*Butter.*—The butter of the county is mostly put up in tubs or mugs, weighing about 75 to 84 lbs. each. Chester, Liverpool, and Shrewsbury, are the markets; price in Dolgellan about 10*d.* per lb., salt, an article the Welsh are too free with in their butter: if they would use less they would sell their butter at a better price, and have a quicker sale for it.

'*Wages*—taking the qualities of the servants into consideration, are high: I would rather pay double the wages to a Lancashire servant, either male or female, than I would to a Welsh servant; they are generally crammed with conceit, stubborn, &c.; and those who have not seen farming in England, fancy all the knowledge the English have of agriculture is derived from them, when in fact they are a century behind the English;—show them a good short-horn beast, they will say—not good, not black: show any of the improved breeds of pigs or sheep, their remark would be—of pigs, that their ears are not long enough, their ears ought to cover their eyes, so that they cannot see, then they will fatten; but if their ears are short and cock up, they can see everything, and it is impossible for them to fatten. Their remarks about sheep are quite as ridiculous: mind, these remarks do not apply to Flintshire and Denbighshire; these counties border on England, consequently the inhabitants are a little more civilised. Men's wages: head ploughman, living in the house, from 9*l.* to 15*l.* per annum, according to the size or respectability of the farm; 2nd ploughman, 6*l.* to 9*l.*; ploughman out of doors, finding his own meat, 20*d.* per day. The average quantity a man will plough in a day is not more than ½ an acre; and in mowing they will not get over much more ground, besides doing their work very imperfectly. Shepherd's wages from 6*l.* to 12*l.*, living in the house; cowman's wages, 5*l.* to 8*l.* living in the house; lads from thirteen to eighteen years, from 30*s.* to 4*l.* per annum, according to strength and

ability. Women's wages: head dairy-maid, from 6*l.* to 8*l.*; 2nd dairy-maid, from 4*l.* to 6*l.*; other female servants, from 30*s.* to 4*l.*, according to age and ability. All the women-servants work in the field when required, at such work as planting and gathering potatoes and at harvest-time, loading or spreading muck, or turning and stacking turf.

'The rents in this country are high, particularly on small farms, where, what with rent and poor-rates, I hardly know how they contrive to live; but live they do, but very hard: for dinner you will see a small farmer have half a salt herring, with potatoes and butter-milk (very poor food for a working man); his wife and family must content themselves with butter-milk and potatoes; or perhaps, after the father has finished his part herring, there will be a scramble amongst the youngsters for the bones to suck as a treat. I forgot to mention that they sometimes have a little skim-milk cheese with oaten-bread. Some better off than others, muster bacon; yet the amount of poor and county-rates these men pay per annum will amount to from 4*l.* to 5*l.* each; in fact, the paupers live better than these men. The cloth they wear they weave from wool of their own growing, both men and women; the men a kind of frieze, and the women linseys.

'The landlords of the country stand sadly in their own light in not granting leases to tenants who are respectable on the large farms, or such as have a sufficient capital to conduct such farms: they can never expect their estates to be improved until they do grant leases; for who in his senses would lay out money in draining and other improvements without some kind of security for his outlay? Thus it is that improvements on the best farms have been neglected. The drill-system is general for turnips and potatoes throughout Wales; they are seldom seen in beds, except in small patches.'

I have given the above at great length, as it is highly illustrative of many minor points of agricultural economy; the remarks are perfectly applicable to all the poorer districts.

The country extending in length from Festiniog in the north to Dolgelly in the south, and from the Arenigs in the east to Cardigan Bay in the west, a tract of about 20 miles each way, is wholly occupied in grazing black cattle and sheep; the farms are large and the country thinly inhabited; the cattle are not all brought to the homestead during the winter, but are housed in detached buildings at some distance from each other, with a herdsman to look after each lot; this system is forced upon the upland grazier, as, from the absence of tillage and good perennial or artificial meadows, the farmer in such a situation would be forced to sell off in autumn the whole of his stock, except about six or eight head, for which he can manage to collect sufficient provender adjoining his homestead, the manure from the consumption of which furnishes the dressing for a patch of potatoes, followed subsequently by oats and grass-seeds, it would be utterly impossible for the mountain grazier to collect at one spot

provender to last during winter for 50, 60, or 100 head of cattle, especially when it is taken into consideration that there is an almost entire absence of tillage; he is therefore necessitated to erect the buildings for the shelter of his cattle during winter in the spots where he can collect the greatest quantity of winter forage; these spots are, as I have previously had occasion to mention, situate on or at the margin of some deep alluvial soils or peat moss, which yields the latter part of the year a considerable quantity of coarse rough marsh hay, possessing little nutriment, but sufficient to keep the cattle from starving; it is rare to find more than six or eight head of cattle housed at one place. It will be quite apparent that, in the total absence of cultivated green crops, such as turnips, rape, &c., there is no better course for the mountain farmer to pursue, as to draw home hay from a variety of spots (many of which would be some miles apart from the dwelling) over deep mossy land, as there are no roads, would entail a degree of labour, both of men and horses, for which his means would be totally inadequate; in fact, if he could obtain the means, the value of the produce would not repay the labour, and if he kept extra horses purposely, it must be borne in mind that the cost would indirectly be heavy, as he would have to summer graze a smaller number of cattle in proportion; besides, the horses would themselves devour a large portion of the hay which they might draw home for winter consumption; under all circumstances, therefore, the system described as pursued in the mountain district now under notice, and the remarks are applicable to other districts similarly situated, is the only one which the mountain grazier, with his present knowledge, can with safety pursue; indeed I can venture to assert that, all circumstances considered, it is his very best course, until he becomes more intimate with an improved system: whether opportunities and facilities exist for such improved system is a question for consideration hereafter.

How far are any peculiar Practices in the Husbandry of North Wales justified by peculiarities of Soil and Climate?

It would be unfair in reviewing the system of agriculture practised throughout North Wales, to draw a comparison between the same, and that followed in the best agricultural districts of England, such as Lincolnshire, Norfolk, Suffolk, parts of Northampton, Cambridge, and Essex, places which, whether we consider the general ability of the farmers, super-excellence in implements, and skill in using them, large capital, quantity and quality of stock, either separately or collectively, stand preeminent over all other parts of the world. Admitting all the excellencies that exist in the districts alluded to, it must not be

forgotten that their improvement was greatly promoted by being adjacent to, and connected with, good roads to the metropolitan market, whilst Wales has been, from its great distance, shut out from the same market, or at all events labouring in that respect under great disadvantages. The facilities of steam navigation have, however, opened to Wales, within the last twenty years, a market in the manufacturing districts equal to the metropolitan one, the beneficial effects of which are just making themselves visible; as it is, the agriculture of Wales will bear a comparison with the agriculture of Lincolnshire and Yorkshire at the time of Arthur Young's earliest agricultural tour: under these circumstances let us therefore indulge in the pleasing hope that a similar beneficial change will develop itself in Wales in the course of the next twenty years.

In the days of our Saxon ancestors, whose agricultural wealth mainly consisted of herds and swine, it was customary with them at the latter end of the year to slaughter immense quantities of stock, which was salted and used for winter provisions—the want of green crops forcing such a measure upon them—the store stock only being reserved, such as cows in calf, yearlings, two-years old, &c., it is evident that, with fat cattle, there was no other course to pursue, as they would loose during the winter all the flesh and fat put on during the summer months. On the mountains in the western part of North Wales a similar system is pursued, the only difference being that, instead of fattening and slaughtering the animals, they are drafted off and sold to the farmers possessing richer lands on the eastern sides of the country, and the English borders, where they are finally fattened off for the butcher; a good portion are also sold off as in-calf cows, about a month or six weeks previous to calving, generally at the third or fourth calf, when they have assumed the highest value as milkers. Cattle bred on the mountains find their way gradually to Llangollen, Chester, or some other border fair; a yearling heifer will probably change hands three or four times before it is finally disposed of at its highest value, either as a milker or fat beast in some of the richer border districts. As a general rule, however, mountain-bred animals frequently change hands; it usually occurs that they are taken from a poor to a better district at every transfer of ownership; of course a considerable number of the produce are killed when calves. How far is this practice justified? is the next inquiry to be made: the answer is brief; under existing circumstances there is no other course for the mountain farmer to pursue. My Dolgelly friend has described the course of sheep husbandry on the hills, with this exception, that large numbers of lambs are drafted off at the latter end of spring or beginning of summer, which are fattened in the more

fertile vales. On the smaller mountain farms I saw several patches of gorse planted for the purpose of serving as winter provision; but they were not cultivated with such neatness of management as to render the example worthy of exact imitation, whilst a preponderating number depend upon the hedges for their supply. That the system of growing gorse as winter food for stock might be extended in Wales with great advantage, I am willing to admit; but in the management of what I saw grown, there was certainly nothing peculiarly interesting. In no part of North Wales would the advantages of extending the alternate system of husbandry be so permanently conspicuous and profitable as upon those elevated mountain farms where the grazing of black cattle forms the principal occupation of the farmer, as on most of such farms there are extensive tracts of peat moss easily reclaimable, particularly those places from which the indifferent crop of hay is now procured. There are wide-spread tracts of land—and the remark applies particularly to Merionethshire and the western part of Montgomeryshire adjoining thereto, which by paring, burning, draining, and liming, would produce excellent crops of turnips and rape (the latter especially), which would enable the farmer to maintain as large, if not a larger, amount of stock in winter than summer; besides the practice would give him the whole amount of profit derivable from the rearing of the calf until the ox was fit for the butcher. From extensive experience I am aware that before such heath or bog land, which almost always contains a considerable amount of vegetable matter, can be profitably cultivated, it is indispensably necessary that lime be applied to the same; the question therefore of future improvement is in a great measure restricted to the facility with which that substance can be procured, and the cost of the same. It unfortunately happens that the great extent of bog and heath land alluded to is at a considerable distance from limestone and a still greater one from coal: there are, however, besides the extensive band of carboniferous limestone which stretches from Llanymenach through the counties of Flint and Denbigh to the Ormsheads, and appears again in the island of Anglesey, independent beds and outcroppings of limestone, which are to be found stretching in two or three bands through the Berwins, the principal one known as the Bala limestone, and adjacent to the eastern side of the Arenigs and the western side of the Hiraethog range.

Mr. Davis says of this limestone, that

'Its north-eastern extremity commences at Cader Dinmael, near Cerreg y Druidion, where lime was burned in the seventeenth century. There it may be observed on the right hand side of the road leading to Glyn Deffwys; afterwards at Llwyn y Ci, near Rhiwlas, and crossing

the river Trywerin to Llanuchlyn, it is again found at Llanfachrath, Braich y Bedw, Blaenaw, Hengurtucha, Caer Ynwch; and last of all, Bwlch coch, near Cader Idris. Other places where this grey limestone is found, in a line parallel with the former, are Rhiwaedog, and at the other side of the Berwin at Rhiwarth, at Bryn Melyn, Cwym Hyfed, Bwlch y Groes, and Cwm Tylyddian, near Llanymowddy.'

It is also found at Craig y Glyn, and a parallel band to the Bala limestone passes through the Berwins, called by geologists the Hirnant limestone. Knowing the value of limestone in moory districts, I was anxious to obtain specimens of the various strata of limestone just described, but in consequence of taking the new instead of the old road from Bala to Llangynog, I entirely missed seeing the Hirnant Bands; I however got my guide to take me to the Bala series, and I collected some specimens from a heap of broken limestones that lay beside an old limekiln; the guide informed me that the country people had ceased to use the Bala limestone for many years; indeed the broken stones appeared as though they had been exposed to the weather some years; the kiln also appeared to have been disused for a long time; a specimen I have since analyzed, and I find that, when calcined, it yields 49 per cent. of lime.* I have not had an opportunity of analyzing the impurities, but they apparently consist of silica and alumina. This limestone burns to a grey or brownish colour, and is too impure to be used for building purposes; but the country people say it is stronger for manure than white lime; if this is really the case, doubtless some of the impurities consist of substances forming the earthy constituents of plants. As lime is generally applied to boggy land, it is not at all unlikely that the silica is the principal additional fertilizing ingredient. That the Rhiwlas, Glyn Diffwys, and Bala series of limestones are overlooked at the present day, I had ample means of noticing; amongst other places I may mention that I found lime composts preparing 6 miles from Bala on the Festiniog road, the lime for which had been brought from Gwerclas,† near Corwen, a distance of 16 miles, although the Glyn Diffwys beds were absolutely within a couple of miles from the spot. The Bala and analogous limestones can be, and are, burned with turf, which is a great advantage, as peat is almost always to be found in abundance in its vicinity.

Lime being procurable, the mountain farmer may safely com-

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* The specimen alluded to above had the appearance of ordinary carboniferous limestone, being of a grey colour and crystalline. It consisted of 12 per cent. of earthy matter insoluble in acids, and 88 per cent. of carbonate of lime.

† At Gwerclas there is an insulated lime-rock, which affords the ordinary white lime. It is burned with coals brought from Ruabon: the present price is 8*d.* per bushel at the kiln.

mence draining, and subsequently pare and burn the deepest and most promising parts of his land: lime having been applied, the same should then be sown with turnips or rape; rape for sheep, to be eaten on the ground whereon they grow; the turnips to be drawn for cattle, to be followed by one grain crop; if a spring crop, oats, if a winter one, rye. I would further recommend that some portion of the land, all that eaten by sheep on the ground should have grass seeds sown with the rape, as the pasture from newly reclaimed and consequently unexhausted land so treated and laid down, is of the most luxuriant description. I have seen and tried the experiment, and can vouch for its being a most profitable method. The great elevation of the lands now under consideration precludes the possibility of growing grain with success for a series of years, and the farmer will act judiciously to limit his growth of grain to the amount of straw required for his own consumption. In addition to its hardy nature, rye has peculiar calls on his attention; it yields the largest amount of straw of any grain crop, besides being more economical in use; in such a course, hay following the grain crop will supply the place of straw in winter foddering the cattle, it must be perfectly evident to all that grain is not adapted to places situated as described, whilst the extreme and almost constant moisture of the situation renders it peculiarly adapted to turnips and rape: such a thing as the failure of the latter crops through drought would be unheard. By following such a course, and carefully managing his manure heap, the mountain farmer might, in many places, maintain all the year round more than double, and in some cases treble, the stock which he can now only maintain in summer. If the plan now described was pursued by the farmer, he would soon see the benefit to be derived by purchasing oil-cake, Indian corn, &c., to assist the green crops in more quickly and profitably feeding his stock, in which case his improvement would be complete—this is no doubt testing the matter by a very high standard; but the course is perfectly feasible; and to arrive at excellence or perfection, we must always have the extreme point of either steadily and constantly in view; and like many other matters apparently difficult at the onset, it will be found that every step taken forward renders the next advance easier. The plan described is adapted to many parts of the Hiraethog range; there are, however, in the Hiraethog district many spots where very little lime would be required, such as hazel loams, on which 20 or 30 bushels evenly spread would be a sufficient dressing: on peats I never found less than 80 to 100 bushels effective. Paring and burning has many adversaries; but no improvement of waste land is complete without the process; it is the scourging cropping so frequently practised after

paring and burning that has brought that process into disrepute; the art itself, when properly cropped afterwards, is a ready mode of securing a large amount of the inorganic constituents of plants, in fact sufficient to be productive for a long series of years of permanent fertility. Grass lands in such high situations will have a constant tendency to form moss, so that it will in general be found requisite to break the grass lands up about every six years; by keeping the land in heart, the moss will be kept away much longer than if laid down in a poor exhausted state by over cropping.

Since the original sketch of the preceding observations was drawn up, I have been favoured by a gentleman who has made some improvements on an estate situate in the Hiraethog range; he states :—

"We have not reclaimed uninclosed lands yet. We have been fully occupied in restoring inclosed farms that might be called waste, but which had been long inclosed. One farm was let at 3*s*. 6*d*. per acre, which the tenant failed to pay; it is now valued at 20*s*. Draining is the basis of all our improvements, and I should not recommend any one to invest capital in the improvement of any of the waste land in Wales without making that the first object, more or less thorough according to whether the land is arable or only suitable for pasture. We have planted tracts of waste with a view to cultivate the rest when the shelter gets up: our process of improvement consists in thorough draining, subsoil ploughing, liming, then a crop of oats followed by turnips well manured, then oats or barley with seeds, which lie one, two, three, or more years; this I consider the most profitable farming for our country. We did at one time pare and burn, but I am satisfied it is a most destructive plan, the fruit of idleness, and a false economy; it produces a forcing manure for one or possibly two crops, but at the expense of destroying the best of the surface soil. I have proved that the gorse, heather, and weeds may be effectually eradicated by working the land, first by hand, and then by the Uley Cultivator. I burn the gorse, heather, and couch-grass roots without any of the surface soil, and get in that way a large quantity of ashes for manure; but instead of consuming any of the soil by fire, I disturb the subsoil to get more. The thinner the soil the more injurious the paring and burning."

I regret to add that few such instances of management are to be found in North Wales; it was my original intention to have visited the estate in question, but circumstances prevented my doing so. Whilst on the subject of improvements, I perhaps could not introduce at a fitter opportunity any observations which I may have to make on the subject of catch-work irrigation. On the first view of the case, the feasibility of forming catch-work irrigation in a hilly country like Wales would be apparent; it is only, however, in the vales that great facilities exist for such works. On the mountain sides the streams and torrents generally

flow through deep gullies, so that the water would require to be conducted by a wooden or iron trough from its original course to the adjoining land intended to be irrigated; this in many instances would require an outlay of labour, skill, and expense beyond the means of the mountain farmers. As the streams approach the base of the hills, the inequality between their surface and the inclosing banks gradually lessens, at the same time flowing more equably and gentle, thus better adapted to the supply of an irrigated meadow. I witnessed several faint attempts at irrigation in various parts of Wales, from the bad construction and management of which little or any benefit could be derived; in some instances they only served the purpose of forming incipient peat mosses: besides, when an irrigated meadow is being formed, it ought to be on land in the highest tilth, and laid down with appropriate grass seeds. That there are immense capabilities for this kind of improvement is certain; but the construction of water-meadows should not be left to the unaided efforts of ill-informed persons; a professional person is indispensable to give the first instructions.

The best irrigated meadows that I saw whilst in Wales were in the vicinity of Chirk.

The farming pursued in the vales of secondary quality, placed between the ranges of hills of more moderate elevation than the districts just noticed, is capable of being greatly improved. Catch-work irrigation is generally applicable to the lower lands; the band of arable and pasture lands of inferior quality, say from 4*s.* to 12*s.* annual value per acre, a zone of which lies between the fertile arable land of the vales worth from 15*s.* to 25*s.* per acre per annum, and the uncultivated heath is generally well adapted to the alternate system of husbandry. Were such soils cultivated with rape and turnips, drilled with portable manures, such as bones, guano, &c., it would supply more winter food for stock than the richest pasture, and a crop of grain at intervals would raise sufficient straw. In this manner the land would maintain the largest amount of stock, and yield the greatest pecuniary return to the farmer. I found it a general complaint with individuals whom I conversed with on agricultural matters, that there was no analogy between English and Welsh farming, and, like all others who contend for the beaten track, stated that there was *a peculiarity* respecting the management of Welsh farms; this peculiarity was—what? that the farms varied so much in the quality of the land, each farm possessing every description of soil from the fertile vale to the barren heath. The fact I admit, but not the inferences drawn from it; neither does it justify Welsh farmers for following the course they do. Instead of such a circumstance being a drawback on improvement, it is the greatest

advantage a farmer can possess, *cæteris paribus,* as it gives him a complete command of all the resources of modern husbandry. How rejoiced would a lowland farmer in the richer grazing districts of the eastern counties of England be, were he to have attached and contiguous to his richer lands a tract of the inferior description noticed; what an advantage it would be to him to be enabled to maintain as great an amount of stock on his own farm in winter as in summer, instead of having to sell off a portion in autumn, when prices are the lowest, and purchase again in spring when prices are the highest, or else pay a visit to the upland farmers perhaps 20 or 30 miles distant, and contract with them for the feeding of so many acres of rape to turn his surplus stock into during the winter, at a certain rate per acre according to the luxuriance of the crop; and this he is only enabled to accomplish with such farmers as have not sufficient capital to buy stock themselves, those who have capital preferring to purchase stock and obtain the difference of value between the autumn and spring price in addition to what might have been put on by feeding during winter on such a fattening article as rape or swedes, shearlings and ewes being mostly put on the common white and yellow turnips; the whole of these advantages are in the hands of the Welsh farmer who resides in districts similar to those now under observation, and it is his own fault that he does not derive all the advantages of his situation, viz., moor land for summer grazing young and store stock, rich vale land for summer fattening, and meadow hay for horses and fattening cattle; inferior land to be cultivated with portable manures for the production of winter-grown crops and straw.

A considerable portion of the richer lands in Montgomeryshire, particularly the vale of the Severn, is strong pasture land, for which it is decidedly best adapted; a little more attention to the drainage of the land in question would be an advantage in many instances; the more friable soils are cultivated somewhat after the same manner that is adopted in Shropshire, the adjoining district; lea broken up, wheat, potatoes, turnips manured, oats or wheat, hay, being the best course adopted; it might be improved. In many places a much more scourging course is followed. The first step in improvement throughout Wales would be the adoption of eating off turnips on the field by sheep, or what may be termed the folding system: throughout Wales the turnips are drawn, and if given to sheep, which is a very common practice in Montgomeryshire, they are drawn and thrown on the pastures; generally turnips are given to cattle.

Of the farming of the Isle of Anglesea, it may be observed that it is in general in advance of most other districts of North Wales; in this island there are some large farms well cultivated; I ob-

served that the cattle on it were more uniformly of a black colour than other parts of Wales: the same remark applies also to the part of Caernarvon on the opposite side of the Menai. Mr. Davies, in his report, says that Anglesea at the time of his report exported 8000 head of cattle, including yearling, two, and three year olds. Mr. Culloch says that in 1810 it was 5500. The sheep are much larger than in other parts of Wales, but I attribute this at the present time to the fact of the indigenous sheep having been extensively crossed with the Leicester: the inhabitants state that only few specimens of the true breed now exist. A very important item in the agricultural statistics of Anglesea and that part of Caernarvonshire bordering on the Menai Straits is the quantity of pigs that are reared and fattened, upwards of 20,000 being annually forwarded to Liverpool, shipped from the Menai Bridge; they average from 2½ to 3 cwt. each: the fattening of pigs is one great cause of the potato culture having spread so much more in these districts that in other parts of North Wales. The pigs throughout North Wales are generally of a superior description; some that are bred by Lord Mostyn and Mr. Dawson, of Gronant, may challenge the empire for combining all the various excellent qualities of the porcine race: towards the south-west the large flop-eared ungainly breed sometimes prevail, but these are the exception to the general rule of the country. The farms throughout North Wales are generally of small extent, most of them being under 100 acres of arable and pasture land; they may be stated to usually run from 40 to 150 acres, often with a run of mountain pasture, as previously noticed.

Of the improvements which have been made in the farming of North Wales since the report of the Rev. Mr. Davies, in the year 1810, it is difficult for the writer to form an estimate, as it is quite evident that Mr. Davies's report is drawn up from observations made over a period extending from 1795 to the year in which the report was published. At page 274 he shows that enclosure acts were obtained for 93,000 acres up to 1809, which were either completed or in a progressive state; it must, however, be borne in mind that enclosed is here meant. not cultivated. The high prices obtained for all descriptions of agricultural produce, up to the year 1815, being a great encouragement to the cultivation of inferior soils, doubtless a great quantity was so cultivated, and subsequently allowed to return to its former state; the aspect at the present day of several of the places named as having obtained enclosure acts by Mr. Davies, has been sufficient evidence to me that such has been the case; the last quoted letter is further confirmatory of the circumstance: in several other places, where enclosure acts are mentioned as having

been obtained, I had the pleasure of witnessing thriving plantations of timber; the latter is the case only when the enclosure has been attached to large properties. Notwithstanding these remarks, there has been a gradual advance during the last twenty-five years in agricultural improvement, but in no place is this so much marked as in the island of Anglesea; and as far as I was informed, there has been a similar advance in the best parts of the county of Montgomeryshire; an improvement has been slowly progressing in the more fertile districts during the period named, turnip husbandry having made a permanent, though not extensive, footing on the best soils, a more rapid development could not be expected in a pastoral district; instead of the awkward ploughs alluded to by Mr. Davies, I generally found light iron ploughs in use, worked with two horses harnessed abreast: in some parts of Merionethshire and Montgomeryshire I saw the horses yoked two and sometimes three in a line; but the practice was not general. One-horse carts were in general use, and waggons in the eastern part of Montgomeryshire. The horse in general use throughout North Wales is a hardy useful animal of the description which Morland used to delight to paint in farm-yard, watering, and blacksmith-shop scenes; in the richer part of Montgomeryshire there exists a most excellent breed of draught horses, from which place and Shropshire, Liverpool and Manchester are mainly supplied with draught horses. In my description of the equine genus, I ought not to omit an account of the wild ponies called Merlins, the breeding of which is nearly confined to that part of Montgomeryshire bordering on the south-western portion of the Berwins. Many small farmers do not possess a horse, and some who farm 100 acres will only keep one; in these cases two neighbours similarly situated reciprocally lend their horses to each other; those without any can generally get their work down for about 10*s*. per acre. The ploughing is generally done in a workmanlike manner, and a kindly feeling and goodwill usually subsists amongst neighbours to assist each other, and in a thinly peopled district is found particularly advantageous at harvest-time. Sheep are shorn in the upland district by neighbours mutually assisting each other on appointed days.

The cattle is of the black breed in general: they are hardy, good milkers, and adapted to their situation. Several gentlemen have introduced the Ayrshire and Galloway breeds; the latter are looked upon by the country people as mere whims of the gentry. The first object ought to be to produce nutriment capable of sustaining superior breeds; until then the old breed will maintain its ground, and under present circumstances will prove the best.

The indigenous sheep of North Wales are small and ill-formed, yielding only about 1 lb. of wool per fleece per annum. The mutton is uncommonly sweet and good; according to pasturage and age they will weigh from 30 to 45 lb. per carcass. Mr. Davies alludes to the Kerry breed of sheep, but I had an opportunity of carefully examining them: I found a cross between some of the English breeds and the common Welsh breed in the more fertile districts, and on the road from Welsh Pool to Oswestry I saw several flocks of Southdowns of good make and size: the Southdowns might be introduced with great advantage on the drier and more fertile hills, when the dip of the underlying rock happens to be at a high angle, the numerous fissures forming natural drains to carry off any undue quantity of moisture. The whole of the poorer soils on the extensive carboniferous limestone formation are well adapted to the rearing of Southdown sheep. The farmers do not smear their sheep as in Scotland and the north of England. I was informed that a Scotchman in the neighbourhood of Arran Mowddy has introduced the Scotch black-faced sheep, and that he was in the habit of smearing them; with what success the introduction has been attended I was not able to ascertain. The wool from the store stocks of the mountain farmers is of very indifferent quality, being kempy and of uneven staple; this arises from want of food or cold stopping the animal's growth: whether smearing would be of advantage to the Welsh breed I am not in a position to give an opinion.

The introduction of the cultivation of flax into North Wales would be a great boon; a great extent of the moderate upland soils, especially on the lime-rocks, being peculiarly well adapted to the growth of the finest description of flax. Mr. Davies states, page 409 of his report—"The late Hon. Thomas Fitzmaurice, of Lleweni, in the vale of Clwyd, in order to encourage his tenants in Ireland, and to promote the national manufacture, received his rents in *brown linen;* which he brought over to the bleaching-house he had erected for the purpose, about the year 1780, near Lleweni, at the expense of upwards of 20,000*l.*, the most elegant structure of the kind in Europe. For some time about 4000 pieces were annually imported and bleached; and the honourable manufacturer, unmindful of peerage, coronets, and noble blood, regularly attended Chester fairs in person, and for the time metamorphosed the brother of the Marquis of Lansdowne into a linendraper." The same Sir Thomas Fitzmaurice erected a handsome Linen Hall (which still exists) in Liverpool for the promotion of the same laudable object, as well as a handsome town residence adjoining. Unfortunately for the country, the career of Sir Thomas was cut off before he could see his designs carried into effect; had Sir Thomas introduced the culti-

vation of flax instead of the bleaching of linen into Wales, I think it likely that North Wales would at this time rival the north of Ireland both as regards the growth and manufacture of this article. The proprietor who first introduces and encourages the growth of this textile will deserve the lasting gratitude of his country. The cultivation of flax would materially hasten the abandonment of the present absurd system of cropping until the land is exhausted, which is ruinous alike to tenant and landlord, as flax can only be grown with profit on land in good heart.

The dwellings of farmers occupying more than 40 acres of land are generally good substantial stone buildings with slate roofs. The greater part of them have been built within the last twenty or thirty years, and do credit to the taste of the landlords. The outbuildings are generally few, the mode of farming not needing an extensive outlay in that respect: as agriculture advances these will become necessary and important adjuncts.

The history of the agriculture of Wales is similar to that of others similarly circumstanced. First solely grazing; next a little tillage is combined therewith; next manures are economised and applied to the cereal crops and meadows, subsequent to which an advanced step is taken by the introduction of green crops and alternate husbandry. Welsh farming may be said to be in the transition state between the two last-named systems: a few energetic examples are only required to put everything in a fair way for progression, as there exists in Wales every material for the most perfect system of agriculture. The landlords in general deserve credit for the moderate amount of rent charged, though, from deficiency of skill in the cultivator, there can be no doubt that many are hard pressed to meet their engagements. As far as I could judge, the rent of good land at a distance from any large town or village would average about 20*s.* per acre, with poor rates from 3*s.* to 4*s.* Though the rents in the island of Anglesea were represented to me by a gentleman who had considerable opportunities of being well informed on the subject, as amounting on the best lands to 30*s.* per acre; in this, however, I believe he includes the rents of land in the vicinity of Bangor, Amlwch, &c. From my own observation I should not conceive the rents in Anglesea to be higher than other parts of North Wales. Artificial manures have been introduced amongst farmers on the best soils. A correspondent from Anglesea says they are used to a considerable extent. In these matters our opinions are formed relatively to pre-existing practices. I should pronounce their use being confined to a very limited extent. I have previously remarked upon the poverty of the manures made on mountain farms; the greater part of the country is obnoxious to similar remarks. It will be apparent to every one that manure

derived from cattle fed upon straw alone will be sufficiently poor without the aid of mismanagement: on the very best farms in the best districts there does not exist that careful attention to the preparation of manures that is desirable: lime, where found, is much abused. The peasantry throughout North Wales are generally hardy, honest, and industrious. The usual wages for an able-bodied farm labourer is about 9*s*. per week. Miners, that is such as are strictly so, and work under the surface, average 12*s*. to 16*s*. per week. The principal food of the labouring classes is oatmeal, with which they can do very well during the summer when milk is plentiful; when that becomes scarce some ingenuity is requisite to make it a little savoury: a not uncommon practice is to steep the finest oatmeal some days in water, it is afterwards boiled; this dish is called flummery, and is eaten with treacle and water. In the absence of cheese and butter, in any quantity, it is by no means an uncommon practice to stew onions with a little pepper and butter, and spread the same on oat-cake. Cheese and butter are the favourites when they can be obtained. There is considerable attention to that emphatic word COMFORT amongst the humblest classes of both sexes, more so, I think, than is to be seen in any other part of the United Kingdom in proportion to their means. In the mountain districts the dwellings of the labourers, and the remark applies to some occupied by farmers, there is much room for improvement, being often too confined for either decency or health: with the exterior I have no fault to find, being composed in all cases of substantial stone and mortar-built walls and slated roofs. A more extended window for the admission of light would be beneficial. I am afraid the reason why these confined dwellings continue to be constructed and inhabited arises from the scarcity of fuel; for though these places are only found where turf is plentiful, it must be remembered that a sheep-farm requires the continued supervision of the farmer throughout the year, and leaves him little time for the preparation of fuel; besides, the season may totally prevent the preparation of turf: the labourer's time is, of course, still less at his own disposal.

Turnips are always in drills, and potatoes are generally so. Turnips are gradually making their way into cultivation, but they form at present a very minor part of the husbandry of North Wales. The county of Flint, the adjoining part of Denbighshire east of the Hiraethog range, Anglesea and Montgomeryshire south-east of the Berwins, are the places in which turnips are principally cultivated. I am certain there are not 200 acres of turnips in the county of Merionethshire or Caernarvon; they are only seen about the Menai Straits and Conway. Notwithstanding there are rich corn-growing soils, some of which are well

managed, and grow most luxuriant crops of every description of grain, the average produce of North Wales is decidedly below the average produce per acre of Great Britain; not more than 20 bushels of wheat, and 26 to 28 ditto of Barley and Oats. This deficiency in the average arises from the pernicious practice so prevalent throughout the country, of taking two, three, or four corn crops in succession, and breaking up the lea again within two, three, or four years of so exhausting a course.

North Wales does not grow sufficient grain for its own consumption, large quantities being introduced from Ireland and England. This is further proved by the circumstance, that though Wales is decidedly a poorer country than England, yet the averages taken for fixing the duty on foreign grain are higher in North Wales than any other part of Great Britain, although the grain sold in the Welsh markets is of inferior quality to the average of the kingdom. Considerable changes have, no doubt, taken place since the survey was made, an extract from which is given at the head of the present report, but certainly not so much as to permit it to be supposed that Montgomeryshire possessed at that time 296,960 acres of woods and waste, as it certainly at the present time does not contain near so many acres of waste land and woods as Merionethshire (70,000); the former certainly possesses more wood, but not to an extent to approximate to anything like the number of acres set down as woods and waste. If the account was correctly made, two things must have occurred to have changed the appearance of Montgomeryshire so materially since the survey was made, viz., that it must have been denuded of wood to a great extent, and also a vast surface of waste land must have been brought into cultivation. I could not glean any evidence of either having occurred to such an extent as to amount to anything like the quantity set down in the survey. That both the causes alluded to have taken place there can be no doubt, but to what extent I am not in possession of sufficient data to form an opinion; certainly not so great as to coincide with the survey. Merionethshire possesses the greatest amount of waste land of any county in North Wales at the present day, as is pretty evident from its small population, although it possesses extensive slate-quarries and mines of lead, manganese, &c., which employ a considerable portion of its population.

Pasturage is another very vague term. Taking the county of Denbigh, for instance, in which there is certainly more waste land in the Hiraethog range alone than would amount to 5000 acres—if heath and a wretched soil may be considered waste. Nor is it the fact that one-sixth of the soil of North Wales is arable: it is evident that the quantity of land set down under the heads noticed are not correct; were they so, Wales ought certainly

to be independent of other districts for its supply of grain, for the reasons now noticed. I have not endeavoured to give any estimate of the extent of waste land, or such as is reclaimable; to do so would only mislead, and at the best could merely be an approximation. I have endeavoured to set out the limits of such by as correct a descriptive account as I could; and I believe the reader will, with a good map, be enabled to inform himself sufficiently well. Wales is essentially a pastoral country at present, which, independent of the circumstance of its being a corn importing country, is further proved by the fact that its principal agricultural exports consist of lambs, sheep, cattle, butter, and cheese. The greatest quantity of cheese is made in the vales of Wrexham and Clwyd, several dairies from which districts are sold at the Chester cheese-fairs at the highest price, the mode of making cheese in these vales being precisely similar to that practised in the neighbouring county of Chester. Butter is made principally by the smaller farmers, particularly in the western districts, where little cheese is made.

I have not introduced an account in this report of the quality and description of stock maintained by several gentlemen and noblemen for the purpose of improving or replacing the native breeds, as they are merely isolated instances of well-meant endeavours to improve the character of the agriculture of the country; let it suffice, that generally speaking, the adoption of such improved breeds is almost invariably confined to the farms of the well-meant introducers. The first object should be to render the soil more productive; improved stock would speedily afterwards be adopted. Draining is about being partially adopted. Of the more backward districts Mr. Price, of Rhiwlas, appears to carry on draining in the most energetic manner, and gives the most encouragement.

Although there are a number of small landowners, the major part of the landed property of North Wales is in very large estates; and it is well worth the consideration of the most extensive owners whether it would not be to their own and their tenants' advantage to form about twenty model farms in various parts. The overlookers of each should be made to keep a correct account of all incomings and outgoings, so as to satisfy the surrounding farmers that the adoption of an improved system would be to their pecuniary advantage. The whole of these twenty model farms should be under the control of one clever person employed for the purpose, who should receive a stated salary, and in part be paid by a commission out of the profits of the various farms under his supervision; each separate farm to be conducted by an ordinary working farmer, selected for the purpose for his industry and integrity, who should merely be required to conduct the manual

operations of the farm; the course of cropping and manuring to be solely directed by the principal agriculturist. Twenty proprietors, subscribing 20*l.* each per annum, would accomplish such an undertaking, and would soon add 20 per cent. to their present rental.

February 25*th*, 1846.

P. S.—Since the preceding was written I have received permission from Henry Sandbach, Esq., of Hafodornos, Denbighshire, to announce his being the party who kindly furnished me with the information which appears in the preceding report respecting their mode of improving some land in the Hiraethog range (which I had not the opportunity of visiting) which had previously been mismanaged. I make this acknowledgment the more readily as I have from several parties heard the spirited improvements of the Messrs. Sandbach spoken of in high terms.

T. R.

Appendix.

I have to acknowledge myself indebted to several gentlemen who favoured me with their correspondence on matters connected with the preceding paper, for which favours I here respectfully take leave to return them, collectively and individually, my sincere thanks, for obtaining the addresses of several gentlemen who take an interest in agricultural improvements. I feel particularly indebted to Messrs. Britton and Evans of Chester, the respective editor and publisher of that cheap and useful little work the 'Farmer's Herald,' which I was glad to perceive was unostentatiously making its way in many a remote nook and glen in North Wales, doubtless acting as the pioneer of future improvement. Of the three letters quoted in the report, one respecting the agriculture of the vicinity of Dolgelly is from my old and esteemed acquaintance, James Taylor, Esq., of Plas Gwanas: the one on the farming of the Vale of Clwyd is from Thomas Jenkins, Esq., of Plas y Ward, near Ruthin; the other letter, on the mode adopted at Hafodornos for improving worn-out or neglected lands, is from Henry Sandbach, Esq., of that place. On all hands I have heard warm praise of the improvements effected on their estates by the Messrs. Sandbach.

The Map.

Independent of the various rocks described by lines, it must be remarked that nearly the whole of the country left blank and bordering on England belongs to the coal-measures; as is also that part of Flint which borders on the estuary of the Dee; the space left blank in the Isle of Anglesea also represents the coal-measures. The extensive alpine country extending from the Menai Straits to Machynlleth is principally composed of igneous intermixed with slate and grauwacke rocks, a large portion of which belongs to the Cambrian system.

T. R.

Holyhead
Anglesea
Beaumaris
Menai
Bangor
Caernarvon
CAERNARVON
BAY
Capel Curig
Holywell
Flint
Chester
Mold
Denbigh
Ruthin
Wrexham
Holt
Tremadoc
Criccieth
Arenig
Bala Lake
Bala Limestone
Harlech
Llanfair
CARDIGAN
BAY
Barmouth
Sarn Badrig
Cader
Idris
Dinas
Mowddy
Tal y llyn
Machynlleth
Llanfair
Welshpool
Oswestry
R. Severn
Igneous Rocks
Mica & Chlorite Slate
New Red Sandstone
Limestone
Upper Silurian
Lower Silurian

XXXIX.—*On the Double Culture of Turnips between Peas.* By CHARLES HANNAM.

To Mr. Pusey.

SIR,—Having had three years' experience of growing peas in the place of making a summerland, and afterwards drilling turnips between the rows, I take the liberty of sending you an account of it for insertion in the Royal Agricultural Society's Journal, if you think the information worth communicating.

I adopted the practice from a highly cultivated and well-kept farm in my neighbourhood, in the occupation of George Hooper, Esq., of Cottington, whose system for many years past has been to make a summerland only for swede turnips, contracting with a London seedsman to grow white peas, which he has sown on the portion of his ground intended for common turnips; I had observed the excellent turnips he almost invariably grew after peas, better indeed than I, before artificial manure was introduced, could obtain after preparing a summerland. His practice (which I at first followed, but had not after the first year the same facilities and command of manure for continuing) is to carry out from a mix-hill made on purpose, about two-thirds of a full coat of manure before ploughing his wheat stubble for peas, but my greater difficulty of procuring this extra quantity of dung, at a time when all the spare dung from the yards was required for beans, taught me to succeed as well, and I think at less cost and trouble, with artificial manure.

On my first trial in 1844, not being able to make a contract with a seedsman, I obtained, as well as I could, the proper kind from Mark Lane, and had three sorts of white peas sent down to me; all three that year produced well, averaging respectively 3 quarters 6 bushels, 4 quarters 3 bushels, and nearly 5 quarters per acre. Part of the ground on which the first lot grew was manured from a mix-hill, and there the turnips after them were moderate only, the pea-straw covering the young plant too strongly and thickly; but in another field of the same quality of land, containing rather less than 8 acres, which had been treated with 3 cwt. of Peruvian guano in the spring, and afterwards with some manure rotted to mould and mixed with turf-ashes drilled in with the turnip-seed, I had a most excellent crop of green-rounds, which kept 16 score of tegs two months all but 5 days. The 4 qrs. 3 bush. peas were too late a sort, and had too much bine, leaving me plenty of plant, but the turnips did not bulb well. Where I grew nearly 5 qrs. per acre, I had sown 2½ cwt. of guano only, and had a very fair piece of white round turnips.

In 1845 I grew 10½ acres of early frames for Messrs. Batt

and Rutley, and 10 acres for the late Mr. Bristow; also 12 acres of the double-blossom frames (if such is their proper name), which had the year before produced nearly 5 qrs. per acre. Batt's and Bristow's were both manured with 3 cwt. guano in the spring, and farm-yard manure rotted to mould and screened with ashes as before, when the turnips were drilled; the ungenial summer produced but 2 qrs. to the former lot per acre, and 2 qrs. 2 bush. to the latter, but most excellent green and white turnips on both. The 12-acre piece, which had no guano, but received the mould and ashes, produced 2 qrs. 3 bush. per acre of peas, and the turnips not so good.

This year, as well as the last, I allowed the mould and ashes to miss at certain places, where the guano had been broad-casted before the peas, but could observe no difference in the size of the turnips; but where guano was purposely omitted on Mr. Bristow's lot, and on the 12-acre piece, it was discernible both in the colour of the peas and size of the turnips.

The season of 1846 has been memorable for the dolphin among the pea-crop, and a dry hot seedtime for turnips. I have grown principally the double-blossomed frames, and some of Mr. Bristow's early frames. I have used both guano, and bones dissolved in sulphuric acid, manuring for the turnip only; the guano turnips have, I think, turned out best, but the season has not been a favourable or fair one for making equal experiments.

I will now proceed to detail the method of growing and managing the double crop, which from the foregoing experience I consider the best and most economical. As a system it can only be carried out where the farm is kept habitually very clean, and all cuich-grass, if not scarified in the wheat-gratten after harvest, carefully forked out, as well as in the clover leys; and the horse and hand hoeing, and thistling well executed as soon as required. The portion of the farm intended for common turnips (swedes I have never attempted as a double crop) being ploughed as usual in the winter a good depth, is niggetted or stirred as much before the 1st of April, or after the pressure of barley season, *as possible*, and 3 cwt. of good Peruvian guano, mixed with an equal quantity of light mould, sown broadcast in the track made by the tines of the niggett, being covered in immediately by the harrow which precedes the pea-drill; four bushels of early frames are deposited in rows of 12 to the rod wide, and as soon as high enough are hand-hoed at 3*s.* 6*d.* per acre, then horse-hoed, then quickly hand-hoed again, and at the last slightly earthed as the horse-hoe follows, by means of a band tied above the plate, the final horse-hoeing being timed just before the peas meet together. The turnip-drill should now follow immediately, and if convenient for drilling 12 furrows to the rod, will take 3 or more furrows at a

time; forked irons are attached to the drill, which drawing a line on either side of each furrow, closes the earth upon the seed lightly, and while it is moist. If the land is very clean, the first hand-hoeing may be omitted; indeed, unless despatch is made there is little time for two, as the peas soon *shake hands* across the furrow, and to attempt to hoe after they have done so, or have *squatted,* will of course be an injury by the passage of the implement over the pea-crop. I have named the 1st of April as the time for putting in the peas, as a guide of time only, the pressure of barley season being seldom over before; but white peas and all peas avoid the dolphin, and crop generally best when put in as early in the year as the land will suit; by the same general rule I name the 1st of June for the turnips, whereas it may happen, if the peas are forward, the turnips must be drilled in May.

It is preferable to broadcast the guano before the peas are sown, as, letting alone any advantage to the peas, it has not been found that the peas draw the guano too much from the turnips: it causes less labour and trampling than when drilled with the latter, as well as being less liable to burn broadcasted, unless when drilled with a large proportion of mould. If I had to choose between guano drilled with the turnips, and bones dissolved in sulphuric acid, I should, I think, prefer the latter to the former used in that way, although generally, or following pea-turnip culture after the plan my experience has led me to think the best, I prefer guano.

The peas are cut by Dutch hoes or shoveshims, with a cross piece to the handle, a boy attending with a hay-fork and clearing the peas out of the way of each man as he severs them; this work costs 5*s*. per acre. When fit to get together, the men take the boys' forks, and with the boys picking up after them, place the peas in narrow rows, at 2*s*. or half the cutting price per acre. If the same set of men and boys can be spared, they may now begin to set out the turnip plants (the boys singling after the hoes) at 6*s*. or 7*s*. per acre, the narrow rows of peas being turned over by old men or women as the turnips under them, or the peas, or the setting out require. The second hoeing should, if possible, be done by the same men as set them out, each to his own ground, at say 5*s*. per acre more.

My average growth for the three years I should set down at $2\frac{1}{2}$ qrs.; deducting for seed 2 qrs., this at 40*s*. per quarter is 4*l*. per acre. If the horsework on the peas and previous preparation of the wheat-stubble are balanced against the horsework of a clean summerland, the extra expense would appear to lie in the two hand-hoeings (if *two* are given), the cutting the peas and getting them together, and perhaps also the extra 1*s*. on each of the turnip-hoeings, in all 16*s*; leaving 3*l*. 4*s*. an acre, and the pea-straw

to outset 36*s*. worth of guano, an item not too much, if not now in every case required where a good crop of turnips is obtained off a clean summerland.

It is somewhat difficult to say what sort of pea, produce and market-price considered, is best for the purpose. A trial of different kinds, unless made under similar circumstances and in the same season, is liable to produce variable results with varying years. The kind need not be governed by the seedsmen's wants or contract, nor will a contract always be advisable; as for instance, the high prices of this season have been much above contract figure. The early frames (such as blossom double on the stalk) appear at present the best sorts known: the requisites are early ripening, short and delicate bine, which will not leaf or house the turnips too much, but allow them to grow through. *Sufficient*, but not too much turnip-seed should be put in; too much, or crowding, tends to spindling, and entangling for setting out. After the peas are in rows the turnip plants require a day or two to look up or to sit up for the hoeing out. A slanting iron is better than an upright one above the plate of the horse-hoe, being less liable to gather weeds and dirt, and earth the turnips.

The above culture requires a good working soil, and rolled lightly and fine after the peas are up: if the ground is cloddy when the turnips are put in (being necessarily unturned and drier than the seed-furrow of a summerland) the proper growth of the seed cannot be depended upon without continued moist weather.

I am also in the practice of growing cole between beans, and generally get some good keep in that way. The shorter the bean-straw of course the more air to the young plants, the beans being manured well in their proper course, and dropped at 10 furrows to the rod: cole seed is put in between the rows after earthing with a handbarrow, a boy following the man with a coarse, narrow-headed rake. The cole should not be too thick or crowded in the rows; it is afterwards horse-hoed, and forms a second crop: being fed off perhaps with lambs with cut meat, or, as it may happen, a small allowance of corn, a month's keep may be obtained for them by this means, closing and improving the land for wheat, and keeping off the turnips till a later period.

I am, Sir, yours obediently,

CHARLES HANNAM.

Deal, Kent, Dec. 28th, 1846.

XL.—*Report on the Analysis of the Ashes of Plants.* By J. Thomas Way, Professor of Chemistry at the Royal Agricultural College, Cirencester; and G. H. Ogston, late assistant to Professor Graham of University College, London.

[This research was conducted in the laboratory of the Agricultural College, Cirencester.]

In laying before the Society this our first report, we deem it desirable to state shortly the objects of the investigation we have entered upon, and the advantages which are likely to accrue to agriculture from our labours.

This plan will possess the additional recommendation of pointing out the direction in which our attention has been turned, and will afford opportunity to any member of this Society interested in the subject to suggest points of inquiry which we may have overlooked or inadequately considered.

It has been long known that plants, besides the organic matter of which their bulk is composed, contain a small quantity of mineral matter, which remains as an ash when the vegetable part of the plant is burned.

From the constant and universal existence of this mineral matter in all plants, it has been concluded that it is essential to their growth.

And careful experiments have proved that where plants are denied access to sources of mineral food, although at the same time abundantly supplied with organic nourishment, they invariably perish.

Again, careful experiments have demonstrated the fact that whilst different plants, and even different parts of the same plant, afford when burned very varying proportions of ash—for the same parts of the same species of plants the quantity of ash does not vary to any extent, or at all events that the difference is by no means so great as that occurring in different plants or other parts of the same plant. Thus, for instance, in two samples of wheat the quantity of ash yielded by the straw, the grain, and the chaff of each might be somewhat dissimilar, but the differences would be trifling as compared with those which would be found to exist between the ash of these parts in wheat and that of the corresponding parts of barley.

Further, not only has the quantity of inorganic matter been found to be pretty constant in the same plant, but its quality or chemical composition, although widely varying in different plants, has been proved to be exceedingly similar for the same part of the same species of plants.

The ashes of plants consist of several chemical substances; they contain silica, lime, magnesia, potash, soda, oxide of iron,

phosphoric acid, sulphuric acid, and common salt, with very frequently carbonic acid, and sometimes oxide of manganese.

The general laws which we have above mentioned have been deduced from a number of ash-analyses made by various chemists at different periods.

But of the numerous analyses of ashes of plants which have been published, a very large portion has been considered by chemists of the present day as unworthy of confidence from want of correctness in the methods employed; whilst others of unquestionable accuracy are either too limited in number or not sufficiently systematic to afford the full information which it is so desirable to possess on this head.

The present investigation was set on foot to supply this deficiency; and we will now proceed to mention the points which we consider require elucidation.

In the first place, it is necessary to ascertain by the analysis of as many specimens of each as the time and labour involved will admit of, the quantity and chemical composition of the mineral matter contained in all plants which are the objects of English agriculture, and of the important parts of such plants.

This knowledge is a most essential element in the construction of any rational system of agriculture, and upon it alone can we hope to select our crops for the soils upon which they are to grow, and judiciously to supply the manure suited to their wants.

Precise information upon this point would in all probability explain to us the advantage of certain rotations which have received the sanction of experience, at the same time suggesting modifications and alterations to suit the mineral peculiarities of each crop.

We should then know what are the crops that, from the large quantity, as well as the valuable character, of the materials they remove from the soil, are really deserving of the name of "exhausting crops." If such plants happened to be consumed for the most part in large towns, or that from any cause their inorganic matter could not be returned to the soil, their cultivation would of course require the employment of artificial manures of composition analogous to that of the ash.

On the other hand, crops of this exhausting character, if fed off on the land or in stalls (the manure, solid and liquid, being studiously preserved and returned to the soil), would be amongst our most efficient agents for the improvement of the land, by bringing to the surface a large portion of valuable salts suited to the necessities of the next crop.

Thus, of two green crops equally valuable in other respects, we should select the one whose ash most resembled in quantity and composition that which the succeeding corn crop would require.

A knowledge of the mineral composition of every plant and each part of such plant, would be the only sure guide to the use of artificial manures—more especially those of an entirely mineral character.

It would enable us to add to the soil exactly that which we had taken from it. In the case of the cereals we should know that in every bushel of wheat or barley we had removed from the soil so much potash, so much silica and phosphoric acid, which must in some shape or other be returned; for we hold it to be no less the duty than the interest of the farmer to restore to his fields an equivalent for the mineral matter of which he robs them in the grain sent into the large towns, of which at present nothing is returned.

It is true that many soils are found when the time for the corn crop comes round possessed of the requisite materials for its perfect growth; these having by the action of the intervening green crops become fitted to serve as food for the cereal. But it is not wise to trust to this, and it is not just to remove from the land twice in every four or five years, as the case may be, valuable mineral matter which is in no way replaced.*

The use of bones for the turnip crop is a partial but most valuable restitution, and the further addition of silicate of potash at some period of the rotation would probably be attended with similar advantages.

But whilst all the materials of the grain are for the most part lost to the soil, the mineral matter of the straw and the chaff finds its way without much loss back to the land from the manure heap. And this leads us to remark that a thorough acquaintance with the mineral constitution of all cultivated plants will afford a corresponding amount of information respecting the inorganic contents of natural manures. For the manure formed from a ton of turnips or a ton of hay must contain the mineral matter of these crops, deducting that trifling proportion which in the case of growing animals is retained for the formation of their bones, &c.

From the known composition of different parts of plants, we might be led to apply them to particular purposes in farm economy, and the manure thus formed might be kept apart and reserved for special applications. Thus Boussingault informs us that the bran of wheat, which, according to his experiments, constitutes on an average from 13 to 20 per cent. of the dry wheat,

* Some allowance must be made for this statement in cases where foreign substances (as oil-cake) are introduced into a farm; the mineral matter contained in these is eventually added to the soil, and is some, although an inadequate, compensation for that carried off in the grain crops.

contains a larger proportion of nitrogenized matter—that is, of gluten and albumen—than the flour itself.

Now, as we have every reason to believe that the phosphates are in some way associated with the gluten, &c., in the grain of the cereals, we should expect that not only would the bran prove a most nutritious article of food for animals, but that their manure whilst fed on it would possess the highest fertilising powers.*

But in addition to the analysis of all the ordinary crops, it has appeared to us necessary to institute a more extended inquiry into the mineral history of one or two of the most important groups—to ascertain the variations in quantity and quality of mineral matter occurring in different varieties of the same plant, and to discover, if possible, the influence of soil, manures, climate, and season on the same variety.

A series of analyses on one description of crop might, we have thought, indicate to what extent one substance could, without injury to the health of the plant or the amount of the product, be substituted for another.

How far a plant, for instance, might be contented with a supply of the cheap alkali soda—in place of its more costly representative—potash.

We should also hope from such a research to ascertain how far the abundant supply of any particular mineral ingredient to a plant might cause a greater proportion of it to be taken up and retained by the plant; or, in the event of such a result failing to occur, whether the circumstance of a plant obtaining ready access to a store of such mineral food might not lead to a more abundant crop, the proportion of its inorganic constituents remaining the same.

On the other hand, we might find that an excess of these substances in the soil exercised no kind of influence on the quantity or quality of the crop—the success of their application when used as top-dressings being solely due to a previous deficiency of the soil in particular mineral matters, and in no way connected with their subsequent superabundance.

Then, again, if it be proved from our researches that the gluten of wheat is invariably attended with a corresponding quantity of phosphates, the question would arise, does the abundant supply of phosphates to wheat lead to a greater devolopment of gluten in it, or, in other words, to the production of a more nutritive specimen of this grain?

One important conclusion would undoubtedly follow from the proof of this association of gluten and phosphates in the

* We believe that an intelligent member of the Society has proved this supposition to be correct, and adopted the practice above mentioned on his farm.

cereals. The use of rich animal manures, which are known to increase the proportion of gluten in wheat, must be accompanied with a plentiful supply of phosphates, otherwise they would fail to produce the desired effect, or in producing it they would greatly exhaust the soil.

Many other cases might be mentioned of the important results likely to follow from a systematic and sufficiently extended investigation into the mineral constituents of plants. Let the foregoing, however, suffice to indicate the importance of the research upon which we have entered.

Circumstances have obliged us to direct our attention at once to the more difficult portion of the inquiry—the influence (namely) which soil, climate, and locality exert upon the character of the mineral components of plants. And the same causes have led us to commence with wheat, concerning which we have gained considerable information.

We have thought it desirable to ascertain the per centage of ash over a very much larger number of specimens than could possibly be submitted to complete analysis, and as some other particulars of these specimens have been obtained, they have been considered worthy of individual description.

We feel that whatever opinions of a practical and theoretical nature we may venture to express from the great familiarity with the subject which such a research cannot fail to produce, our duty to the Society is to furnish its members with every information which will enable them to draw their own conclusions; and we have therefore given a full account of all the specimens upon which any attention has been bestowed.

It will be seen that we have estimated the relative weight of grain, straw, and chaff, on a very large number of specimens of wheat.

For the express purpose of obtaining very perfect samples, long calico bags were forwarded to the different parties who were kind enough to furnish us with specimens. In these the heads with the straw attached were thoroughly enveloped, so that they reached us in a state of perfect integrity.

The relation of the different parts was ascertained by rubbing out the grain of 30 or 40 heads, separating every portion of chaff from the straw, and carefully weighing the three products. That this method is capable of giving good average results we have proved by determining the proportion of the different parts on a very much larger quantity than that above named.

The latter estimation has been found to agree very nearly with that on the smaller scale. In order that this point may be clearly understood, we subjoin the particulars of several cases.

Case 1.—*Specimen of Hopeton Wheat.*

(Estimation on 30 or 40 heads.)

	Actual Quantities in Grains.			Per Centage.	
Grain . .	1,855	or	Grain . .	45·6	
Straw . .	1,828	,,	Straw . .	45·0	54·4
Chaff . .	384	,,	Chaff . .	9·4	
	4,067			100·0	

(Estimation on a larger quantity.)

	Actual Quantities in Grains.			Per Centage.
Grain . .	10,650	or	Grain . .	45·0
Straw, Chaff .	13,031	,,	Straw, Chaff .	55·0
	23,681			100·0

This deviation of per centage between the large and small quantities is quite within the errors of analysis.

On the large specimen the straw and chaff were weighed together, on account of the immense labour involved in their perfect separation, which has always, however, been effected on the small samples. In all the instances given the grain was separated entirely by hand.

Case 2.—*Another Specimen of Hopeton Wheat.*

(Estimation on 40 or 50 heads.)

	Actual Quantities in Grains.			Per Centage.	
Grain . .	2,112	or	Grain . .	42·45	
Straw . .	2,453	,,	Straw . .	49·3	57·55
Chaff . .	410	,,	Chaff . .	8·25	
	4,975			100·00	

(Estimation on a larger quantity.)

	Actual Quantities in Grains.			Per Centage.
Grain . .	18,160	or	Grain . .	42·4
Straw, Chaff .	24,676	,,	Straw, Chaff .	57·6
	42,836			100·0

Case 3.—*Specimen of Hopeton Wheat.*

(Estimation on 60 or 70 heads.)

	Actual Quantities in Grains.			Per Centage.	
Grain . .	4,500	or	Grain . .	37·5	
Straw . .	6,650	,,	Straw . .	55·46	62·50
Chaff . .	840	,,	Chaff . .	7·04	
	11,990			100·00	

(Estimation on a full-sized sheaf.)

Actual Quantities in Grains.				Per Centage.
Grain . .	26,450	or	Grain . .	37·74
Straw, Chaff .	43,650	,,	Straw, Chaff .	62·26
	70,100			100·00

CASE 4.—*Specimen of Red-Straw White Wheat.*

(Estimation on about 60 or 70 heads.)

Actual Quantities in Grains.				Per Centage.	
Grain . .	4,980	or	Grain . .	44·7	
Straw . .	5,220	,,	Straw . .	46·86	55·3
Chaff . .	940	,,	Chaff . .	8·41	
	11,140			100·00	

(Another estimation on about 30 heads made at a different time.)

Actual Quantities in Grains.				Per Centage.	
Grain . .	1,141	or	Grain . .	46·25	
Straw . .	1,120	,,	Straw . .	45·4	53·75
Chaff . .	206	,,	Chaff . .	8·35	
	2,467			100·00	

(Estimation on a large sheaf.)

Actual Quantities in Grains.				Per Centage.
Grain . .	30,100	or	Grain . .	46·1
Straw, Chaff .	35,170	,,	Straw, Chaff .	53·9
	65,270			100·0

We have given the two estimations on small quantities in the above case, because the deviation from the result obtained in the large specimen is more manifest than in any other instance.

One of the small quantities gives almost exactly the same proportions as the large; and what after all is the amount of error in the other instance? It is somewhat less than 1·5 per cent.

Our most sanguine expectations did not contemplate so near an approach to accuracy as even this; but the other results we have stated are still more satisfactory, and demonstrate that the method we have adopted is not open to any serious objection. We have been thus minute on this point as our results appear somewhat to militate against the notion generally entertained respecting the proportion of straw and grain.

We shall, however, reserve our further remarks on this subject to the conclusion of the report.

The general methods employed in the estimation of the quantity of ash and in its analysis have been submitted to the scrutiny of the Chemical Committee appointed by the Society, and, having been sanctioned by its members, need not be here detailed.

Before commencing the account of different samples of wheat, we desire to express our deep obligations to those gentlemen who have supplied us with specimens.

An extended inquiry of this nature could only be successfully carried forward with the co-operation of those engaged in agricultural pursuits, and we have much pleasure in acknowledging that the assistance we have received has been most ample. Our thanks are due to Sir John Johnstone, Rev. Mr. Huxtable, Mr. Pusey, Dr. Daubeny,* Mr. David Bowly, and Mr. Zachery, of Cirencester, Mr. Farmer, of Enfield, Mr. Arkell, of this College, and Mr. J. C. Morton, of Whitfield. From the two latter gentlemen we have received unremitting attention and assistance.

We are also deeply indebted to Mr. Henry Tanner, of Exeter, to whose labours we owe all the estimations of straw, grain, and chaff, together with the determinations of specific gravity, and other valuable and important results contained in this report.†

The opinion of each crop given with its history is that of Mr. Arkell, who joins to the knowledge of a practical farmer that familiarity with the value of different specimens of wheat which is pre-eminently possessed by the miller, with whose occupations and calling Mr. Arkell is practically and perfectly acquainted.

Specimen No. 1.—Hopeton Wheat.

Field 30. *College Farm.*

[*Soil*, stone-brash and clay; *subsoil*, rock and clay; *geological formation*, forest marble and Bradford clay; undrained. After rye-grass and clover mown for hay, 2 tons per acre. Drilled at 9 inches in November, 1845; appearance of the crop not very good; *reaped;* carried August 15th. Estimated yield per acre, 24 bushels; straw mildewed, pretty strong; grain good quality, 60 lbs. to the bushel.]

* Want of time has prevented us from analyzing many samples which have come into our hands; the examination of a most interesting series of specimens of barley received from Dr. Daubeny is unavoidably *deferred* to a future time on this account.

† Mr. Tanner has been for more than a twelvemonth an industrious student in my laboratory; his careful and methodical habits are an abundant guarantee for the accuracy of the results above alluded to. They were, however, all obtained under the superintendence of my colleague, Mr. Ogston, or myself.—J. I. Way.

Average length of straw . . . 36 inches.*

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain	1680	43·26		1000·	
Straw	1860	47·90	56·74	1107·2	1311·5
Chaff	343	8·84		204·3	
Total	3883	100·00		2311·5	

Specific gravity of the grain . . 1·374†

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain	12·0	1·76	2·00
Straw	13·7	3·85	4·40
Chaff	12·0	9·18	10·43

Quantity of produce and mineral matter removed from an acre of land:—

	Produce. cwt.	Produce. lbs.	Mineral Matter. lbs.
Grain	12	96·0	25·3
Straw	14	26·4	61·4
Chaff	1	92·2	25·3
Total	28	104·6	112·0

Specimen No. 2.—Hopeton Wheat.

Field 22. *College Farm.*

[*Soil*, stone-brash (calcareous), very thin; *subsoil*, rock; *geological formation*, great oolite; undrained, but naturally dry. After rye-grass and clover mown for hay. Drilled at 9 inches the latter end of October; the crop appeared weak; *reaped;* carried in August. Estimated yield 16 bushels per acre; straw slightly mildewed, not strong; grain good, 59 lbs. to the bushel.]

Average length of the straw . . 38 inches.

* The ordinary length of the wheat stubble on this farm is 10 inches.

† The *specific gravity* of a specimen of grain is its weight in relation to water (considered as 1000), or in relation to any other specimen. The weight per bushel does not give the actual weight of the wheat, since the quantity of wheat which a bushel measure will contain is dependent on several circumstances, such as the *size* of the grains, the state of roughness or otherwise of the skin, &c., which vary with the weather of harvesting and threshing, and a variety of other causes. Thus, of two specimens of wheat, the one which is in reality the *heavier* may yet give less pounds to the bushel from some one of the causes enumerated. The specific gravity of a wheat is its true weight, irrespective of any sources of error, and is therefore an important point in its history—for if weight be a sure criterion of quality, the specimen of highest specific gravity is also that of most value. The specific gravity appears to depend on the quantity of gluten—the larger the proportion of this substance, in reference to the starch, &c., the heavier the wheat.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain	1855	45·6		1000·0	
Straw	1828	45·0	54·4	986·8	1192·9
Chaff	381	9·4		206·1	
Total	3067	100·0		2192·9	

Specific gravity of the grain . . 1·342

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain	12·0	1·81	2·05
Straw	12·3	3·77	4·30
Chaff	12·0	9·31	10·58

Quantity of produce and mineral matter removed from an acre:—

	Produce. cwt.	lbs.	Mineral Matter. lbs.
Grain	8	48·0	16·0
Straw	8	34·5	35·0
Chaff	1	72·6	18·1
Total	18	43·1	69·1

Analysis of the ash of the grain:—

		Removed from an Acre. lbs.	ozs.
Silica	2·84	0	7¼
Phosphoric Acid	47·00	7	8½
Sulphuric Acid	0·24	0	1⅛
Carbonic Acid	0·23	..	
Lime	3·20	0	8¼
Magnesia	12·71	2	0½
Peroxide of Iron	0·60	0	1½
Potash	33·15	5	4¾
Soda	0·00	..	
Chloride of Sodium	0·00	..	
Total	99·97*	15	15⅞

Specimen No. 3.—April Wheat.

Field 3. College Farm.

[*Soil*, stone-brash (calcareous); *subsoil*, rock mixed with clay; *geological formation*, forest marble; undrained, not requiring draining. After thin crop of swedes fed off on the land. Drilled at 9 inches in the middle of April, 1846; appearance of the crop light, being

* This and the numbers in all the following analyses are not given as the *actual* result, but refer to the *calculated* composition of the ash—charcoal, &c. and loss being deducted. The carbonic acid is not considered as a mineral ingredient of the plant, being formed (it is supposed) in all cases in the burning. The quantity is too small here to render a correction necessary for it, but it is not included in the calculation of the matter removed by the grain from an acre of land.

injured by dry weather; *mown;* carried August 27th. Estimated yield per acre 16 bushels; straw bright and strong; grain good, about 61 lbs. to the bushel.]

Average length of the straw . . 28 inches.

Relation of grain, straw, and chaff :—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	1545	43·95		1000·0	
Straw . . .	1540	43·81	55·05	996·8	1275·3
Chaff . . .	430	12·24		278·5	
Total . .	3515	100·00		2275·3	

Specific gravity of the grain . . 1·387

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	11·0	1·79	2·01
Straw . . .	10·8	3·73	4·18
Chaff . . .	12·5	6·94	7·93

Quantity of produce and mineral matter removed from an acre :—

	Produce. cwt.	Produce. lbs.	Mineral Matter. lbs.
Grain . . .	8	80	$17\frac{1}{2}$
Straw . . .	8	$76\frac{2}{15}$	$36\frac{1}{4}$
Chaff . . .	1	$99\frac{8}{15}$	$14\frac{3}{4}$
Total . .	19	$34\frac{7}{15}$	$68\frac{1}{4}$

Specimen No. 4.—White Spring Wheat.

Field 32. College Farm.

[*Soil,* calcareous clay; *subsoil,* clay; *geological formation,* Bradford clay and forest marble; undrained. After poor crop of vetches fed off with sheep. Drilled at 9 inches, in March, 1846; appearance of the crop bad; *reaped;* carried August 24th. Estimated yield 14 bushels per acre; straw much mildewed and weak; grain middling, 58 lbs. to the bushel.]

Average length of straw . . . 34 inches.

Relation of grain, straw, and chaff :—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	1589	45·83		1000·	
Straw . . .	1530	44·13	54·17	962·9	1181·9
Chaff . . .	348	10.04		219·0	
Total . .	3467	100·00		2181·9	

Specific gravity of the grain . . 1·376

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	11·0	1·74	1·95
Straw . . .	12·0	4·60	5·22
Chaff . . .	11·0	11·56	12·99

Produce and mineral matter removed from an acre :—

	Produce. cwt.	lbs.	Mineral Matter. lbs.
Grain . . .	7	28	$14\frac{1}{10}$
Straw . . .	6	$109\frac{9}{10}$	$40\frac{8}{10}$
Chaff . . .	1	$65\frac{8}{10}$	23
Total . .	15	$91\frac{7}{10}$	$77\frac{9}{10}$

SPECIMEN NO. 5.—BRISTOL-RED WHEAT.

Field 6. *College Farm.*

[*Soil*, brash and clay (calcareous) ; *subsoil*, clay and rock ; *geological formation*, Bradford clay intermixed with forest marble ; undrained. After two years' failure in turnips (last crop of turnips manured with Peruvian guano, $1\frac{1}{2}$ cwt. ; bones, 4 bushels ; ashes, 14 bushels per acre.* Wheat drilled at 9 inches, November 4th, 1845 ; appearance of the crop very good ; *reaped ;* carried August 14th. Estimated yield per acre 32 bushels ; straw strong and bright ; grain good, $61\frac{3}{4}$ lbs. to the bushel.]

Average length of the straw . . 38 inches.

Relation of grain, straw, and chaff :—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	901	46·0		1000·0	
Straw . . .	861	44·0	54·0	955·0	1171·0
Chaff . . .	195	10·0		216·0	
Total . .	1957	100·0		2171·0	

Specific gravity of grain . . . 1·370

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	11·50	1·54	1·74
Straw . . .	12·13	3·92	4·46
Chaff . . .	11·00	11·98	13·46

Produce and mineral matter removed from an acre :—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain . . .	17	72	$30\frac{4}{10}$
Straw . . .	16	95	$84\frac{2}{10}$
Chaff . . .	3	$89\frac{6}{10}$	$57\frac{3}{10}$
Total . .	38	$32\frac{6}{10}$	$171\frac{9}{10}$

* Of the two failures of turnips taking place in consecutive years, the first occurred before the farm came into possession of this College (the farm was entered upon in March, 1845. This specimen (No. 5), together with specimens 7, 8, and 10, are the produce of an experiment in the same field. (The *numbers* of the fields have bee n since slightly altered.)

Specimen No. 6.—Clover's Red Wheat.

Field 7. *College Farm.*

[*Soil*, stone-brash (calcareous); *subsoil*, rock and clay; *geological formation*, forest marble and Bradford clay; undrained. After rye-grass and clover cut for hay. Drilled at 12 inches, 15th November, 1845; appearance of the crop good; *reaped;* carried August 11th. Estimated yield per acre 28 bushels; straw strong and bright; grain second quality, $61\frac{1}{2}$ lbs. to the bushel.]

Average length of the straw . . 40 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain	1372	44·75		1000·0	
Straw	1313	44·72	54·25	978·1	1186·5
Chaff	286	9·53		208·4	
Total	3001	100·00		2186·5	

Specific gravity of the grain . . 1·383

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain	11·0	1·55	1·74
Straw	11·8	3·2	3·61
Chaff	11·0	7·61	8·55

Produce and mineral matter removed from an acre:—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain	15	42	$26\frac{7}{10}$
Straw	14	44	$58\frac{2}{10}$
Chaff	3	$22\frac{9}{10}$	$30\frac{7}{10}$
Total	32	$108\frac{9}{10}$	$115\frac{6}{10}$

Specimen No. 7.—Red-Chaff Dantzic Wheat.

Field 5. *College Farm.*

[Soil and previous crop the same as Specimen No. 5. Drilled at 9 inches, November 5th, 1845; crop appeared light; *reaped;* carried August 11th. Estimated yield 24 bushels; straw bright and stiff; grain good, 61 lbs. to the bushel.]

Average length of the straw . . 38 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain	1430	45·5		1013·2	
Straw	1450	46·1	54·5	1013·0	1197·6
Chaff	263	8·4		184·6	
Total	3143	100·0		2197·8	

Specific gravity of the grain . . . 1·387

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	12·5 . .	1·36 . .	1·55
Straw . . .	10·4 . .	4·87 . .	5·43
Chaff . . .	13·0 . .	12·97 . .	14·90

Produce and mineral matter removed from an acre :—

	Produce. cwts.	Produce. lbs.	Mineral Matter. lbs.
Grain . . .	13	8 . .	$20\frac{5}{10}$
Straw . . .	13	$27\frac{3}{10}$ . .	$80\frac{5}{10}$
Chaff . . .	2	$46\frac{4}{10}$ . .	$40\frac{3}{10}$
Total . .	28	$81\frac{6}{10}$	$141\frac{3}{10}$

Specimen No. 8.—Piper's thick-set Wheat.

Field 6. College Farm.

[Soil and previous crop, &c., same as Specimen No. 5. Drilled at 9 inches, November 4th, 1845; crop appeared short and stiff; *bagged;* carried August 14th. Estimated produce 32 bushels per acre; straw bright and very stiff; grain second quality, 61 lbs. to the bushel.]

Average length of straw . . . 29 inches.

Relation of grain, straw, and chaff :—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	2238 . .	47·59		. . 1000·0	
Straw . . .	2077 . .	44·17	52·41	. . 928·0	1101·0
Chaff . . .	388 . .	8·24		. . 173·0	
Total . .	4703	100·00		2101·0	

Specific gravity of grain . . . 1·350

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	13·5 . .	1·48 . .	1·71
Straw . . .	12·6 . .	5·00 . .	5·70
Chaff . . .	12·5 . .	8·52 . .	9·73

Produce and mineral matter removed from an acre :—

	Produce. cwts.	Produce. lbs.	Mineral Matter. lbs.
Grain . . .	17	48 . .	$28\frac{9}{10}$
Straw . . .	16	$19\frac{5}{10}$ . .	$103\frac{3}{10}$
Chaff . . .	3	$1\frac{7}{10}$ . .	$28\frac{8}{10}$
Total . .	36	$69\frac{2}{10}$	161

Specimen No. 9.—White-Chaff Wheat.

Field 6. College Farm.

[Soil and previous crop, &c., same as Specimen No. 5. Drilled at 9 inches, November 5th, 1845; appearance of the crop good; *reaped;*

carried August 13th. Estimated yield 35 bushels per acre; straw clean and stiff; grain inferior quality, 59 lbs. to the bushel.]

Average length of the straw . . 36 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	1850	50·4		1000·0	
Straw . . .	1533	41·8	49·6	827·3	982·0
Chaff . . .	290	7·8		154·7	
Total . .	3673	100·0		1982·0	

Specific gravity of the grain . . 1·313

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	11·5	1·54	1·74
Straw . . .	10·5	4·74	5·30
Chaff . . .	12·0	10·27	11·61

Produce and mineral matter removed from an acre:—

	Produce. cwts.	Produce. lbs.	Mineral Matter. lbs.
Grain . . .	18	49	$31\frac{8}{10}$
Straw . . .	15	$28\frac{4}{10}$	91
Chaff . . .	2	$95\frac{5}{10}$	$32\frac{8}{10}$
Total . .	36	$50\frac{9}{10}$	$155\frac{6}{10}$

Specimen No. 10.—Hopeton Wheat.

Field 6. *College Farm.*

[Soil and previous crop, &c., same as specimen No. 5. Drilled at 9 inches, November 5th, 1845; crop appeared thin on the ground; *reaped;* carried August 13th. Estimated yield 26 bushels per acre; straw mildewed, pretty strong; grain good, 61 lbs. to the bushel.]

Average length of the straw . . 40 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	2112	42·45		1000·0	
Straw . . .	2453	49·30	57·55	1161·3	1355·6
Chaff . . .	410	8·25		194·3	
Total . .	4975	100·00		2355·6	

Specific gravity of the grain . . 1·354

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	11·0	1·51	1·69
Straw . . .	12·2	3·77	4·46
Chaff . . .	11·0	11·34	12·74

Produce and mineral matter removed from an acre :—

	Produce. cwts.	Produce. lbs.	Mineral Matter. lbs.
Grain	14	18	24
Straw	16	$49\frac{8}{10}$	$69\frac{4}{10}$
Chaff	2	$84\frac{2}{10}$	35
Total . .	33	40	$128\frac{4}{10}$

Analysis of the ash of the grain :—

		Removed from an Acre. lbs.	ozs.
Silica	1·42	0	$5\frac{4}{10}$
Phosphoric Acid	46·18	11	$1\frac{5}{10}$
Sulphuric Acid	0·48	0	$1\frac{8}{10}$
Carbonic Acid	none.	..	
Lime	2·82	0	$10\frac{8}{10}$
Magnesia	13·99	3	$5\frac{6}{10}$
Peroxide of Iron	trace.	..	
Potash	33·00	7	$14\frac{8}{10}$
Soda	2·07	0	$7\frac{9}{10}$
Chloride of Sodium	none.	..	
Total	99·96	24	0

Specimen No. 11,—Spalding Wheat.

Field 22. *College Farm.*

[*Soil*, stone-brash (calcareous); *subsoil*, rock; *geological formation*, great oolite; undrained, not requiring draining. After rye-grass and clover mown for hay. Drilled at 9 inches, the end of October, 1845; appearance of the crop good; *reaped;* carried early in August. Estimated yield 30 bushels per acre; straw strong and bright; grain second quality, 61 lbs. to the bushel.]

Average length of the straw . . 38 inches.

Relation of grain, straw, and chaff :—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain	1330	45·13		1000·0	
Straw	1316	44·67	54·87	988·5	1211·1
Chaff	300	10·20		222·6	
Total . .	2946	100·00		2211·1	

Specific gravity of grain . . . 1·377

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain	12·0	1·81	2·05
Straw	10·5	3·57	4·05
Chaff	11·5	7·30	8·24

Produce and mineral matter removed from an acre :—

	Produce. cwts.	Produce. lbs.	Mineral Matter. lbs.
Grain	16	38	$37\frac{5}{10}$
Straw	16	17	$73\frac{3}{10}$
Chaff	3	$71\frac{4}{10}$	$33\frac{6}{10}$
Total . .	36	$14\frac{4}{10}$	$144\frac{4}{10}$

Analysis of the ash of the grain :—

		Removed from an Acre. lbs. ozs.
Silica	2·23	0 $13\frac{3}{10}$
Phosphoric Acid	48·21	18 $1\frac{2}{10}$
Sulphuric Acid	0·11	0 $0\frac{6}{10}$
Carbonic Acid	0·22	..
Lime	2·88	1 $1\frac{2}{10}$
Magnesia	11·06	4 $2\frac{3}{10}$
Peroxide of Iron	0·23	0 $1\frac{3}{10}$
Potash	29·76	11 $2\frac{5}{10}$
Soda	5·26	1 $15\frac{5}{10}$
Chloride of Sodium	none.	..
Total	99·96	37 $5\frac{9}{10}$

Specimen No. 12.—Hopeton Wheat.

[The seed of which specimens 1, 2, and 10 are the produce.]

Specific gravity of the grain . . 1·371

Per centage of water and ash in the grain :—

Water.	Ash.	Ash calculated on dry substance.
13·0	1·48	1·70

Analysis of the ash of the grain :—

Silica	5·91
Phosphoric Acid	41·22
Sulphuric Acid	1·91
Carbonic Acid	none.
Lime	4·29
Magnesia	13·57
Peroxide of Iron	1·36
Potash	27·06
Soda	4·08
Chloride of Sodium	0·55
Oxide of Manganese	trace.
Total	99·95

Specimen No 13.—Creeping Wheat.

*Furnished by Sir John Johnstone.**

[*Soil*, clay, sand, and grit; *subsoil*, clay and sand; *geological formation*, coal-grit of the middle oolite; drained. After poor crop of turnips fed off. (The turnips were raised by 10 or 12 good cart-loads of short manure from the yard.) Sown broadcast in the middle of January, 1846; the crop appeared tolerable, but thin in patches; *bagged* August 22. Estimated yield 16 bushels per acre; straw of middling strength; grain good, 62 lbs. to the bushel.]†

* The weight per bushel given for the specimens 13 to 28, is not the result of actual weighings, but as near an approximation as Mr. Arkell's judgment would afford.

† From a farm in the occupation of Mr. Thomas Leadlay, Surgate-brows, Silpho, N.R. of York.—For the careful collection and a full description of all these specimens we are much indebted to Mr. Turnbull, the agent of Sir John Johnstone at Harkness.

Average length of the straw . . 39 inches.

Relation of grain, straw, and chaff :—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	429	46·58		1000·0	
Straw . . .	411	44·62	53·42	957·7	1145·7
Chaff . . .	81	8·80		188·0	
Total . .	921	100·00		2145·7	

Specific gravity of the grain . . 1·375

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	11·50	1·55	1·75
Straw . . .	10·52	4·33	4·83
Chaff . . .	13·13	16·47	18·96

Produce and mineral matter removed from an acre :—

	Produce. cwts.	Produce. lbs.	Mineral Matter. lbs.
Grain . . .	8	96	$15\frac{3}{10}$
Straw . . .	8	54	$41\frac{1}{10}$
Chaff . . .	1	$74\frac{4}{10}$	$30\frac{7}{10}$
Total . .	21	$00\frac{4}{10}$	$87\frac{1}{10}$

Specimen No. 14.—Talavera or Spring Wheat.

From Sir John Johnstone.

[*Soil*, sand, clay, and grit; *subsoil*, sand and grit; *geological formation*, the coal-grit of the middle oolite; not drained. After poor crop of turnips fed off by sheep (10 or 12 cart-loads of short manure for turnips). Sown broadcast the middle of February, 1846; looked well in May and at harvest; *bagged* August 22nd. Estimated yield 20 bushels per acre; straw of middling strength; grain good, 62 lbs. to the bushel.] *

Average length of the straw . . 44 inches.

Relation of grain, straw, and chaff :—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	576	42·73		1000·0	
Straw . . .	677	50·22	57·27	1175·0	1339·9
Chaff . . .	95	7·05		164·9	
Total . .	1348	100·00		2339·9	

Specific gravity of the grain . . 1·37

* From the same farm as No. 13 specimen.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	13·60	1·59	1·83
Straw . . .	14·00	4·00	4·65
Chaff . . .	12·01	14·38	16·34

Produce and mineral matter of an acre :—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain . . .	11	8	$19\frac{7}{10}$
Straw . . .	13	1	$48\frac{3}{10}$
Chaff . . .	1	$92\frac{4}{10}$	$29\frac{4}{10}$
Total . .	25	$102\frac{4}{10}$	$97\frac{4}{10}$

Specimen No. 15.—White Wheat.

From Sir John Johnstone.

[Soil, subsoil, and previous crop, &c., identical with No. 13. Sown broadcast about the middle of February. Crop appeared towards harvest tolerable, but thin in patches; *bagged* August 22nd. Estimated yield 16 bushels per acre; straw tolerably strong, but weathered; grain pretty good, 60 lbs. to the bushel.]

Average length of the straw . . 40 inches.

Relation of grain, straw, and chaff :—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	580	42·61		1000·0	
Straw . . .	687	50·48	57·39	1184·0	1345·4
Chaff . . .	94	6·91		161·4	
Total . .	1361	100·00		2345·4	

Specific gravity of the grain . . 1·368

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	13·50	1·68	1·94
Straw . . .	12·07	3·36	3·82
Chaff . . .	13·19	13·00	14·97

Produce and mineral matter of an acre :—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain . . .	8	64	$17\frac{1}{10}$
Straw . . .	10	16	$38\frac{2}{10}$
Chaff . . .	1	$62\frac{8}{10}$	$22\frac{7}{10}$
Total . .	20	$30\frac{8}{10}$	78

SPECIMEN NO. 16.—TALAVERA OR SPRING WHEAT.

*From Sir John Johnstone.**

[*Soil*, calcareous loam; *subsoil*, rock; *geological formation*, oolitic limestone; undrained. Old grass-land broken up for oats in the spring of 1839. After poor crop of diseased potatoes, raised by 14 or 15 cart-loads of farm-yard manure per acre, sown broadcast at the end of February, 1846; crop appeared thin; *bagged* August 22nd. Estimated yield 12 bushels per acre, the seed being bad; straw small but strong; grain good, 62 lbs. to the bushel.]

Average length of the straw . . 38 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	498	42·93		1000·0	
Straw . . .	575	49·57	56·07	1155·0	1329·9
Chaff . . .	87	7·50		174·9	
Total . .	1160	100·00		2329·9	

Specific gravity of the grain . . 1·373

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	12·00	1·69	1·92
Straw . . .	12·44	5·08	5·79
Chaff . . .	12·21	16·47	18·76

Produce and mineral matter of an acre:—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain . . .	6	72	$12\frac{6}{10}$
Straw . . .	7	$75\frac{3}{10}$	$43\frac{6}{10}$
Chaff . . .	1	$18\frac{1}{10}$	$21\frac{4}{10}$
Total . .	15	$53\frac{4}{10}$	$77\frac{6}{10}$

SPECIMEN NO. 17.—CREEPING WHEAT.

From Sir John Johnstone.†

[*Soil*, calcareous loam; *subsoil*, rock; *geological formation*, oolitic limestone; undrained. After poor crop of diseased potatoes, raised by farm-yard manure, sown broadcast the end of February; looked well till the dry weather set in; *bagged* August 22nd. Estimated yield 20 bushels per acre; straw slender; grain good quality, 62 lbs. to the bushel.]

Average length of the straw . . 39 inches.

* From a farm in the occupation of Mr. William Coulson, Silpho.

† From same farm as No. 16 specimen.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain	464	45·71		1000·0	
Straw	497	48·97	54·29	1071·0	1187·3
Chaff	54	5·32		116·3	
Total	1015	100·00		2187·3	

Specific gravity of the grain . . 1·394

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain	12·5	1·72	1·96
Straw	10·46	5·50	6·14
Chaff	12·00	15·06	17·11

Produce and mineral matter of an acre :—

	Produce. cwts.	Produce. lbs.	Mineral Matter. lbs.
Grain	11	8	$21\frac{3}{10}$
Straw	11	96	73
Chaff	1	$34\frac{2}{10}$	22
Total	24	$26\frac{2}{10}$	$116\frac{3}{10}$

Specimen No. 18.—Creeping Wheat.

*From Sir John Johnstone.**

[*Soil*, hazel loam ; *subsoil*, gravel ; *geological formation*, Oxford clay, covered by calcareous rubble ; undrained. After fair crop of potatoes manured with 12 loads of farm-yard manure. Dibbled November 28th, 1845 ; crop looked very thin ; *bagged* August 22nd. Estimated yield 16 bushels per acre ; straw pretty strong ; grain good, 61 lbs. to the bushel.]

Average length of the straw . . 42 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain	719	42·75		1000·0	
Straw	820	48·75	57·25	1143·0	1341·8
Chaff	143	8·50		198·8	
Total	1682	100·00		2341·8	

Specific gravity of the grain . . 1·387

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain	13·00	1·90	2·18
Straw	12·13	6·83	7·77
Chaff	12·00	14·34	16·25

* From a farm in his own occupation.

Produce and mineral matter of an acre :—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain . . .	8	80	$18\frac{5}{10}$
Straw . . .	9	$107\frac{5}{10}$	$76\frac{1}{10}$
Chaff . . .	1	$82\frac{2}{10}$	$27\frac{8}{10}$
Total . .	20	$45\frac{7}{10}$	$122\frac{4}{10}$

Specimen No. 19.—Creeping Wheat.

*From Sir John Johnstone.**

[*Soil*, a heavy, tough clay; *subsoil*, a red clay; *geological formation*, the coralline limestone; undrained. After tolerable crop of turnips fed off; turnips raised by 8 or 10 cart-loads of short manure from the yard per acre. Drilled December 1st, 1845; crop looked well at harvest; *bagged* August 24th. Estimated yield 22 bushels per acre; straw of middling strength; grain good, 62 lbs. to the bushel.]

Average length of the straw . . 42 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	826	45·38		1000·0	
Straw . . .	857	47·09	54·62	1032·0	1197·8
Chaff . . .	137	7·53		165·8	
Total . .	1820	100·00		2197·8	

Specific gravity of the grain . . 1·376

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	13·00	1·50	1·72
Straw . . .	10·05	4·08	4·54
Chaff . . .	12·00	11·97	13·60

Produce and mineral matter of an acre :—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain . . .	12	20	$20\frac{4}{10}$
Straw . . .	12	63	$57\frac{4}{10}$
Chaff . . .	2	$2\frac{1}{10}$	27
Total . .	26	$85\frac{1}{10}$	$104\frac{8}{10}$

Specimen No. 20.—Talavera or Spring Wheat.

From Sir John Johnstone.†

[*Soil*, tough clay; *subsoil*, calcareous clay; *geological formation*, coralline limestane; undrained. After crop of turnips eat off. Six cart-

* From a farm in the occupation of Mr. John Cockerill, Hackness.

‡ From a farm in the occupation of Mr. Thomas Hopper, Suffield.

loads of straw manure per acre applied for the turnips. Sown broadcast in March, 1846 (4 bushels per acre of good seed); crop looked well and even at harvest; *bagged* August 24th. Estimated yield 32 bushels per acre; straw strong and clean; grain good, 62 lbs. to the bushel.]

Average length of the straw . . 43 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	908	41·56		1000·0	
Straw . . .	970	47·59	55·44	1068·0	1244·1
Chaff . . .	160	7·85		176·1	
Total . .	2138	100·00		2244·1	

Specific gravity of the grain . . 1·363

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	11·00	1·6	1·79
Straw . . .	11·73	5·98	6·77
Chaff . . .	11·00	15·24	17·12

Produce and mineral matter of an acre:—

	Produce. cwts.	Produce. lbs.	Mineral Matter. lbs.
Grain . . .	17	80	$31\frac{4}{10}$
Straw . . .	18	$102\frac{9}{10}$	$130\frac{9}{10}$
Chaff . . .	3	$13\frac{3}{10}$	$53\frac{2}{10}$
Total . .	39	$8\frac{2}{10}$	$215\frac{5}{10}$

Specimen No. 21.—Hammond's Wheat (or Golden Drop?).

*From Sir John Johnstone.**

[*Soil*, free clay loam, in a low situation exposed to floods; *subsoil*, clay; *geological formation*, blue clays of the coal-grit (oolitic), but covered here by alluvium; drained. After naked summer fallow, sown broadcast about Christmas; crop wasted by flood, otherwise looked well and promised 28 bushels; *bagged* (?) August 24th. Estimated crop 10 bushels per acre; straw tolerably strong; grain second quality, 60 lbs. to the bushel.]

Average length of the straw . . 40 inches.

Relation of grain, straw, and chaff:

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	1187	46·92		1000·0	
Straw . . .	1116	44·11	53·08	932·4	1123·6
Chaff . . .	227	8·97		191·2	
Total . .	2530	100·00		2123·6	

Specific gravity of the grain . . 1·354

* From a farm in the occupation of Mr. Herbert Prodham, Harwood Dale, N. R. of Yorkshire.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	13·5 . .	1·94 . .	2·24
Straw . . .	11·0 . .	4·65 . .	5·22
Chaff . . .	16·0 . .	13·71 . .	16·32

Produce and mineral matter of an acre :—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain . . .	5	40 . .	$11\frac{6}{10}$
Straw . . .	4	$111\frac{4}{10}$ . .	26
Chaff . . .	1	$2\frac{7}{10}$ . .	$15\frac{7}{10}$
Total . .	11	$42\frac{2}{10}$	$53\frac{3}{10}$

Specimen No. 22.—Red Britannia Wheat.

*From Sir John Johnstone.**

[*Soil*, strong; *subsoil*, cold, very strong clay; *geological formation*, blue clays of coal-grit series (oolitic); undrained. After seeds down two years; 5 loads of short farm-yard manure applied for the wheat; sown broadcast early in November; crop appeared very thin, straggling, and light; *bagged* August 24th. Estimated yield (hardly) 16 bushels; straw stiff and short; grain good quality, 62 lbs. to the bushel.]

Average length of the straw . . 28 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	789 . .	52·56		. . 1000·0	
Straw . . .	578 . .	38·51	47·44	. . 730·0	899·0
Chaff . . .	134 . .	8·93		. . 169·0	
Total . .	1501	100·00		1899·0	

Specific gravity of the grain . . 1·369

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	12·00 . .	1·82 . .	2·07
Straw . . .	10·90 . .	5·16 . .	5·79
Chaff . . .	13·00 . .	14·48 . .	16·64

Produce and mineral matter of an acre :—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain . . .	8	96 . .	18
Straw . . .	6	52 . .	$37\frac{3}{10}$
Chaff . . .	1	$56\frac{5}{10}$ . .	24
Total . .	16	$92\frac{5}{10}$	$79\frac{3}{10}$

* From a farm in the occupation of Mr. George Hopper, Harwood Dale.

Specimen No. 23.—Red Wheat.

*From Sir John Johnstone.**

[*Soil*, weak clay loam ; *subsoil*, clay and sand, *wet ; geological formation*, blue clays of coal-grit ; undrained. After naked summer fallow, 6 or 8 loads of good rotten farm-yard manure per acre applied for the wheat ; sown broadcast in November ; crop looked well towards harvest, but the seed was two years old, and much of it did not come up ; *bagged* August 24th. Estimated yield 20 bushels per acre ; straw strong, but weathered ; grain weak, 60 lbs. to the bushel.]

Average length of the straw . . 38 inches.

Relation of grain, straw, and chaff :—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	1140	47·09		1000·0	
Straw . . .	1048	43·29	52·91	919·3	1162·2
Chaff . . .	233	9·62		242·9	
Total . .	2421	100·00		2162·2	

Specific gravity of the grain . . 1·352

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	11·50	1·75	1·98
Straw . . .	12·07	5.65	6·42
Chaff . . .	13·50	13·02	15·05

Produce and mineral matter of an acre :—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain . . .	10	80	21
Straw . . .	9	94	62
Chaff . . .	2	$67\frac{4}{10}$	$35\frac{3}{10}$
Total . .	23	$17\frac{4}{10}$	$118\frac{3}{10}$

Specimen No. 24.—White Wheat.

From Sir John Johnstone.†

[*Soil*, weak sandy clay, but dry, having been furrow-drained ; *subsoil*, clay alternating with sandy seams ; *geological formation*, blue clays of coal-grit ; drained. After turnips fed off with sheep. (The manure for the turnips consisted of 8 or 10 loads of farm-yard manure, 2 loads of ashes, and a load or two of a compost of sea-weed and soil applied to the worst parts.) Sown broadcast February 12th, 1846 ; looked poor in May till harrowed—afterwards improved wonderfully, and was at harvest a nice even crop ; *bagged* August 24th. Estimated yield 24 bushels per acre ; straw strong, but weathered ; grain good quality, 61 lbs. to the bushel.]

* From Mr. Herbert Prodham's farm.

† From a farm in the occupation of Mr. John Willis, Scalby, N. R. of Yorkshire.

Average length of the straw . . 41 inches.

Relation of grain, straw, and chaff :—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	970	45·67		1000·0	
Straw . . .	981	46·19	54·33	1009·0	1187·2
Chaff . . .	173	8·14		178·2	
Total . .	2124	100·00		2187·2	

Specific gravity of the grain . . 1·351

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	13·0	1·59	1·82
Straw . . .	14·0	4·00	4·65
Chaff . . .	12·0	13·46	15·29

Produce and mineral matter of an acre :—

	Produce. cwts.	Produce. lbs.	Mineral Matter. lbs.
Grain . . .	13	8	$23\frac{3}{10}$
Straw . . .	13	21	59
Chaff . . .	2	$36\frac{8}{10}$	$35\frac{1}{10}$
Total . .	28	$65\frac{8}{10}$	$117\frac{4}{10}$

Specimen No. 25.—Creeping Wheat.

*From Sir John Johnstone.**

[*Soil*, red clay; *subsoil*, red sand and clay, with rubble; *geological formation*, grey stone—a species of oolitic limestone; undrained. After good crop of turnips, all eat off by sheep; turnips raised by 16 bushels of bones, and 1 load of ashes with 6 loads of farm-yard manure per acre. Sown broadcast the first week of January, 1846; looked thin in May, but improved and turned out well; *bagged* August 24th. Estimated yield 24 bushels an acre; straw strong grain of good quality, 61½ lbs. to the bushel]

Average length of the straw . . 40 inches.

Relation of grain, straw, and chaff :—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	1020	46·28		1000·0	
Straw . . .	1001	45·42	53·73	981·4	1160·9
Chaff . . .	183	8·31		179·5	
Total . .	2204	100·00		2160·9	

Specific gravity of the grain . . 1·367

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	12·00	1·70	1·93
Straw . . .	10·84	3·73	4·18
Chaff . . .	13·00	13·40	15·40

* From the farm of Mr. William Hopper, of Hackness.

Produce and mineral matter of an acre :—

	Produce. cwts.	Produce. lbs.	Mineral Matter. lbs.
Grain . . .	13	20	25
Straw . . .	12	$4\frac{5}{10}$	54
Chaff . . .	2	$40\frac{9}{10}$	$35\frac{5}{10}$
Total . .	27	$65\frac{4}{10}$	$114\frac{5}{10}$

Specimen No. 26.—Creeping Wheat.

*From Sir John Johnstone.**

[*Soil*, a mixture of clay and sand; *geological formation*, Kelloway's rock. After seeds. The wheat manured with 50 stone ($6\frac{1}{4}$ cwts.) of guano per acre; drilled; appearance of the crop thin and even, and free from smut; *bagged* August 7th.† Estimated yield 30 bushels an acre (the general yield of the field, 6 acres, being about 28 bushels; the straw was rather more where the guano was applied); straw very weak; grain good quality, 62 lbs. to the bushel.]

Average length of the straw . . 44 inches.

Relation of grain, straw, and chaff :—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	7713	40·79		1000	
Straw . . .	9830	51·91	59·21	1272	1451
Chaff . . .	1366	7·30		179	
Total . .	18909	100·00		2451	

Specific gravity of the grain . . 1·365

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	11·50	1·73	1·95
Straw . . .	11·00	4·22	4·74
Chaff . . .	11·00	15·40	17·30

Produce and mineral matter of an acre :—

	Produce. cwts.	Produce. lbs.	Mineral Matter. lbs.
Grain . . .	16	68	$32\frac{2}{10}$
Straw . . .	21	$13\frac{9}{10}$	$99\frac{8}{10}$
Chaff . . .	2	$108\frac{9}{10}$	$51\frac{1}{10}$
Total . .	40	$70\frac{3}{10}$	$183\frac{3}{10}$

* From Wrench Green Farm, Hackness.

† The portion selected for analysis was cut close off to the ground. The rest of the field was *reaped* at the same time. Our calculations of produce of straw are based on the former, and would therefore differ somewhat from the result of the reaping.

Analysis of the ash of the grain:—

		Removed from an Acre. lbs. oz.
Silica	5·20	1 $10\frac{7}{10}$
Phosphoric Acid	46·49	14 $10\frac{4}{10}$
Sulphuric Acid	0·61	0 3
Carbonic Acid	none.	none.
Lime	1·50	0 $7\frac{8}{10}$
Magnesia	12·35	3 $15\frac{5}{10}$
Peroxide of Iron	0·22	0 $1\frac{1}{10}$
Potash	31·18	10 $6\frac{8}{10}$
Soda	2·42	0 $5\frac{3}{10}$
Chloride of Sodium	none.	none.
Total	99·97	31 $12\frac{5}{10}$

Analysis of the ash of the *straw*, including the *chaff* belonging to it:—

		Removed from an Acre. lbs. oz.
Silica	73·57	111 $2\frac{5}{10}$
Phosphoric Acid	5·51	8 $5\frac{1}{10}$
Sulphuric Acid	2·14	3 $3\frac{7}{10}$
Carbonic Acid	none.	none.
Lime	5·91	9 0
Magnesia	1·25	1 14
Peroxide of Iron	0·07	0 $1\frac{7}{10}$
Potash	10·51	15 14
Soda	1·03	0 $15\frac{5}{10}$
Chloride of Sodium	none.	none.
Total	99·99	150 $8\frac{5}{10}$

Specimen No. 27.—Creeping Wheat.

From Sir John Johnstone.

[Soil and geological formation, &c., same as No. 26 specimen (part of the same field, and immediately adjoining); the wheat manured with 40 stone (5 cwt.) of Liebig's wheat manure per acre; drilled; crop looked well; *bagged* August 7th. Estimated yield 28 bushels per acre (same as unmanured portion); straw weak; grain good quality, $62\frac{3}{4}$ lbs. to the bushel.]

Average length of the straw . . 45 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain	7165	40·57		1000·0	
Straw	9168	51·92	59·43	1279·0	1464·6
Chaff	1330	7·53		185·6	
Total	17663	100·00		2464·6	

Specific gravity of the grain . . 1·372

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain	11·00	1·65	1·85
Straw	11·93	4·60	5·22
Chaff	12·00	13·05	14·83

Produce and mineral matter of an acre :—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain	16	65	$30\frac{6}{10}$
Straw	21	23	$109\frac{3}{10}$
Chaff	3	$86\frac{5}{10}$	$44\frac{9}{10}$
Total	41	$62\frac{5}{10}$	$184\frac{8}{10}$

Analysis of the ash of the grain :—

		Removed from an Acre. lbs.	oz.
Silica	2·55	0	$12\frac{5}{10}$
Phosphoric Acid	45·64	13	$15\frac{4}{10}$
Sulphuric Acid	1·55	0	$7\frac{5}{10}$
Carbonic Acid	none.	none.	
Lime	6·76	1	$15\frac{4}{10}$
Magnesia	13·06	4	0
Peroxide of Iron	0·11	0	$0\frac{5}{10}$
Potash	28·89	8	$13\frac{4}{10}$
Soda	1·40	0	$6\frac{7}{10}$
Chloride of Sodium	none.	none.	
Total	99·96	30	$7\frac{4}{10}$

Analysis of the ash of the straw, including its chaff :—

		Removed from an Acre. lbs.	oz.
Silica	69·66	107	0
Phosphoric Acid	6·62	10	$3\frac{2}{10}$
Sulphuric Acid	3·95	6	$7\frac{8}{10}$
Carbonic Acid	none.	none.	
Lime	7·46	11	8
Magnesia	1·56	2	$6\frac{4}{10}$
Peroxide of Iron	0·28	0	$6\frac{8}{10}$
Potash	10·31	15	$4\frac{2}{10}$
Soda	0·13	0	6
Chloride of Sodium	none.	none.	
Total	99·97	154	$4\frac{4}{10}$

Specimen No. 28.—Creeping Wheat.

From Sir John Johnstone.

[*Soil*, calcareous rubble; *subsoil*, clay; *geological formation*, the Oxford clay. Manured with 160 stone (1 ton) of Liebig's wheat manure per acre; drilled; thin and even crop; *bagged* August 7th. Estimated yield 30 bushels per acre (being 3 or 4 bushels *less* than the rest of the field: the soil is, however, rather inferior, and more exposed to cold wind where the manure was applied); straw weak; grain good quality, 63 lbs. to the bushel.]

Average length of the straw . . 45 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000	
Grain	5770	42·12		1000·0	
Straw	6880	50·24	57·88	1192·0	1373·1
Chaff	1046	7·64		181·1	
Total	13696	100·00		2373·1	

Specific gravity of the grain . . 1·394

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain	11·00	1·71	1·92
Straw	13·00	4·30	4·94
Chaff	11·00	16·54	18·50

Produce and mineral matter of an acre:—

	Produce lbs.	Produce oz.	Mineral Matter. lbs.
Grain	16	98	$32\frac{3}{15}$
Straw	20	$13\frac{5}{15}$	$96\frac{9}{15}$
Chaff	3	$62\frac{7}{15}$	$56\frac{6}{15}$
Total	40	$62\frac{2}{15}$	$185\frac{6}{15}$

Analysis of the ash of the grain:—

		Removed from an Acre. lbs.	oz.
Silica	1·34	0	$6\frac{9}{15}$
Phosphoric Acid	48·53	15	$10\frac{7}{15}$
Sulphuric Acid	none.	none.	
Carbonic Acid	none.	none.	
Lime	3·72	1	$3\frac{2}{15}$
Magnesia	12·74	4	$1\frac{7}{15}$
Peroxide of Iron	1·40	0	$7\frac{2}{15}$
Potash	30·94	10	0
Soda	1·28	0	$6\frac{5}{15}$
Chloride of Sodium	none.	none.	
Total	99·95	32	$4\frac{2}{15}$

Analysis of the ash of the straw, with its proportion of chaff:—

		Removed from an Acre. lbs.	oz.
Silica	69·91	107	$5\frac{6}{15}$
Phosphoric Acid	8·54	13	$1\frac{8}{15}$
Sulphuric Acid	2·33	3	$9\frac{1}{15}$
Carbonic Acid	none.	none.	
Lime	4·94	7	$9\frac{2}{15}$
Magnesia	1·43	2	3
Peroxide of Iron	0·06	0	$1\frac{5}{15}$
Potash	12·48	19	$2\frac{4}{15}$
Soda	0·25	0	$5\frac{5}{15}$
Chloride of Sodium	none.	none.	
Total	99·97	153	$6\frac{9}{15}$

Specimen No. 29.—Red-straw White Wheat.

From the Rev. A. Huxtable, Sutton Waldron.

[*Soil*, 6 inches of good loam; *subsoil*, blue clay, with large admixture of sand; *geological formation*, the green-sand; drained; 3 years in tillage, after 27 tons of carrots per acre raised by guano and ashes. Drilled Oct. 1844; crop looked fine, but was laid. Estimated yield 32 bushels an acre. Grain small, good quality, 61 lbs. per bushel.*]

Specific gravity of the grain . . . . 1·385

Per centage of water and ash in the grain :—

Water.		Ash.		Ash calculated on dry substance.
11·25	. .	1·7	. .	1·91

Analysis of the ash of the grain :—

			Removed from an Acre. lbs.	oz.
Silica	9·71	. .	3	$3\frac{5}{10}$
Phosphoric Acid	40·91	. .	13	$9\frac{3}{10}$
Sulphuric Acid	0·08	. .	0	$0\frac{4}{10}$
Carbonic Acid	0·16	. .	. .	
Lime	1·45	. .	0	$7\frac{7}{10}$
Magnesia	9·53	. .	3	$2\frac{5}{10}$
Peroxide of Iron	3·34	. .	1	$6\frac{7}{10}$
Potash	31·00	. .	10	$9\frac{4}{10}$
Soda	2·54	. .	0	$13\frac{4}{10}$
Chloride of Sodium . . .	0·34	. .	0	$1\frac{1}{10}$
Total	99·96		32	13

Specimen No. 30.—Hopeton Wheat.

From the Rev. A. Huxtable.

[*Soil*, 3 inches of loam; *subsoil*, stiff yellow clay; *geological formation*, the clay below the lower chalk; drained. First crop of straw after being broken up from grass. After good crop of turnips (raised with the ashes from paring and burning) fed off by sheep. Sown broadcast, October 30, 1844. Crop laid from height of straw. Estimated yield 32 bushels an acre; grain fair quality, 60 lbs. to the bushel.]

Specific gravity of the grain . . . 1·412

Per centage of water and ash in the grain :—

Water.		Ash.		Ash calculated on dry substance.
9·5	. .	1·56	. .	1·72

* This and the two following specimens were received from Mr. Huxtable early in the month of July: they were of course the produce of 1845, and had been threshed out before they were sent. Owing to this circumstance we can afford no information respecting the quantity of straw. A bundle of the latter accompanied each specimen of the grain, but nothing was done with it, as the analysis of *threshed* straw is anything but satisfactory.

Analysis of the ash of the grain :—

		Removed from an Acre. lbs.	ozs.
Silica	2·28	0	$10\frac{9}{10}$
Phosphoric Acid	45·73	13	$11\frac{4}{10}$
Sulphuric Acid	0·32	0	$1\frac{5}{10}$
Carbonic Acid	none.	. .	
Lime	2·06	0	$9\frac{7}{10}$
Magnesia	10·94	3	$4\frac{5}{10}$
Peroxide of Iron	2·04	0	$9\frac{6}{10}$
Potash	32·24	9	$10\frac{7}{10}$
Soda	4·06	1	$3\frac{2}{10}$
Chloride of Sodium	0·27	0	$1\frac{3}{10}$
Total	99·91	29	$14\frac{8}{10}$

trace of peroxide of manganese.*

Specimen No. 31.—Hopeton Wheat.

From the Rev. A. Huxtable.

[*Soil*, composed of the detritus of flints and chalk (?); *subsoil*, hard chalk ; does not need draining. The land was a coppice; it was broken up two years ago, and planted with Dale's hybrid turnips raised by artificial guano; the turnips eaten with sheep. Sown broadcast, March 20, 1845; stood thick and upright, but was mildewed all in one day; 3 weeks before harvest, a black shade suddenly came over it; reaped; somewhat injured by damp before thatched. Estimated yield 40 bushels an acre; grain *bad quality*, thin, 56 lbs. to the bushel.]

Specific gravity of the grain . . 1·356

Per centage of water and ash :—

Water.	Ash.	Ash calculated on dry substance.
11·5	1·63	1·84

Analysis of the ash of the grain :—

		Removed from an Acre. lbs.	ozs.
Silica	4·43	1	$9\frac{8}{10}$
Phosphoric Acid	45·30	16	$8\frac{5}{10}$
Sulphuric Acid	0·59	0	$3\frac{4}{10}$
Carbonic Acid	none.	. .	
Lime	1·83	0	$10\frac{7}{10}$
Magnesia	12·43	4	$8\frac{5}{10}$
Peroxide of Iron	1·76	0	$10\frac{2}{10}$
Potash	26·92	9	13
Soda	6·08	2	$3\frac{3}{10}$
Chloride of Sodium	0·64	0	$3\frac{7}{10}$
	99·98	36	$7\frac{1}{10}$

* We detected this substance both in Mr. Huxtable's and in some of Mr. Morton's specimens, but not in our own, or those from Sir John Johnstone: it was never in sufficient quantity to enable us to estimate it, and is evidently only an accidental ingredient, and of little importance, as regards wheat at least.

Specimen No. 32.—Piper's Thickset Wheat.

From Mr. David Bowly, Siddington, near Cirencester.

[*Soil*, good loam; *subsoil*, gravel; undrained; after turnips fed off by sheep; turnips raised by farm-yard manure. Drilled first week in February, 1846; crop always looked well; reaped and harvested first week in August. Estimated yield 48 bushels an acre; straw short and stiff; grain middling quality, 59 lbs. to the bushel.]

Average length of straw . . . . . 30 inches.

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	2204	56·7		1000·0	
Straw . . .	1252	32·2	43·3	568·0	762·0
Chaff . . .	432	11·1		194·0	
Total . .	3888	100·0		1762·0	

Specific gravity of the grain . . 1·339

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	11·5	1·73	1·95
Straw . . .	10·5	11·00	12·29
Chaff . . .	12·5	15·51	17·12

Produce and mineral matter removed from an acre:—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain	25	32	49
Straw	14	40$\frac{5}{10}$	177
Chaff	4	14	85
Total . .	43	86$\frac{5}{10}$	311

Specimen No. 33.—White Wheat.

From Mr. Robert Darby, Cirencester.

[*Soil*, alluvial; *subsoil*, strong clay; *geological formation*, the forest marble (member of the inferior oolite); undrained; the land forms part of a nursery, and is under spade husbandry. *Dibbled* 15th February, 1846, 1 foot wide and 4 inches apart, one seed only in in each hole, half an inch deep; crop looked very well; reaped August 6th. Estimated yield 48 bushels an acre; straw strong; thick large ear; grain middling, 60 lbs. to the bushel.]

Average length of straw . . 41 inches.

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	1280	42·90		1000·0	
Straw . . .	1436	48·22	57·10	1122·0	1329·0
Chaff . . .	265	8·88		207·0	
	2981	100·00		2329·0	

Specific gravity of the grain . . 1·382

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	12·00	1·60	1·81
Straw . . .	11·70	7·01	7·92
Chaff . . .	12·00	14·36	16·31

Produce and mineral matter removed from an acre:—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain . . .	25	80	46
Straw . . .	28	$95\frac{3}{10}$	$226\frac{5}{10}$
Chaff . . .	5	$36\frac{2}{10}$	$85\frac{6}{10}$
Total . .	59	$99\frac{5}{10}$	$358\frac{1}{10}$

Specimen No. 34.—French Wheat.*

From Mr. Farmer, of Enfield, Essex.

Specific gravity of the grain . . 1·341

Per centage of water and ash in the grain:—

Water.	Ash.	Ash calculated on dry substance
11·00	1·55	1·74

Analysis of the ash of the grain:—

Silica	3·05
Phosphoric Acid	43 47
Sulphuric Acid	0·35
Carbonic Acid	none.
Lime	3·47
Magnesia	13·94
Peroxide of Iron	0·97
Potash	32·39
Soda	2·32
Chloride of Sodium . . .	none.
Total	99·96

Specimen No. 35.—Egyptian Wheat.

From Mr. Farmer, Enfield.

Specific gravity of the grain . . 1·340

Per centage of water and ash:—

Water.	Ash.	Ash calculated on dry substance.
10·00	1·97	2·19

* We do not possess any history of this and the three following specimens of foreign wheat.

Analysis of the ash of the grain :—

Silica	4·97
Phosphoric Acid	41·03
Sulphuric Acid	0 18
Carbonic Acid	none.
Lime	4 34
Magnesia	11·12
Peroxide of Iron	1·18
Potash	36·60
Soda	0·53
Chloride of Sodium	none.
Total	99·95

Specimen No. 36.—Odessa Wheat (Polish).

From Mr. Farmer.

Specific gravity of the grain . . 1·355

Per centage of water and ash :—

Water.	Ash.	Ash calculated on dry substance.
11·00	1·50	1·68

Analysis of the ash of the grain :—

Silica	4·48
Phosphoric Acid	45·80
Sulphuric Acid	trace.
Carbonic Acid	none.
Lime	3·17
Magnesia	14·28
Peroxide of Iron	0·89
Potash	30·30
Soda	1·00
Chloride of Sodium	none.
Total	99·92

Specimen No. 37.—Marianople Wheat.

*From Mr. Coleman.**

Specific gravity of the grain . . 1·369

Per centage of water and ash :—

Water.	Ash.	Ash calculated on dry substance
10·00	1·7	1·88

* The first part of this report was in the hands of the printer before we received this and two other specimens from Mr. Coleman (who is an intelligent student of this College), and Specimen No. 33 from Mr. Darby. We take this opportunity of acknowledging our obligations to these gentlemen.

Analysis of the ash of the grain :—

Silica	4·00
Phosphoric Acid	34·44
Sulphuric Acid	0·24
Carbonic Acid	..
Lime	2·05
Magnesia	14·09
Peroxide of Iron	trace.
Potash	35·77
Soda	9·06
Chloride of Sodium	none.
Total	99·65

Specimen No. 38.—Hopeton Wheat.

From Mr. J. C. Morton, of Whitfield Example Farm.

[*Soil*, gritty silicious sand; *subsoil*, impure limestone rock; *geological formation*, Silurian; imperfectly drained; 2 years in tillage; after turnips, 20 tons per acre carried off.* Drilled in February, 1846; short straw; patchy crop; *mown* August 12th, carried August 20. Estimated yield 28 bushels per acre; straw middling; grain good, 63 lbs. to the bushel.]

Average length of the straw . . 38 inches.

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain	1620	48·19		1000·0	
Straw	1502	46·67	53·81	926·9	1075·2
Chaff	240	7·14		148·3	
Total	3362	100·00		2075·2	

Specific gravity of the grain . . . 1·403

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain	11·5	1·61	1·81
Straw	14·3	4·09	4·77
Chaff	13·5	12·45	14·39

Produce and mineral matter of an acre :—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain	15	84	$28\frac{4}{10}$
Straw	14	67	67
Chaff	2	$37\frac{6}{10}$	$32\frac{5}{10}$
Total	32	$76\frac{6}{10}$	$127\frac{9}{10}$

* The system of cropping adopted on this farm is (as is very generally known) that of an alternate crop for sale and consumption. The 1st is *always* wheat; the 2nd, successively clover, swedes, beans, and carrots (in alternate rows), and mangold-wurzel. The green crops are never consumed on the land.

Analysis of the ash of the grain:

		Removed from an Acre. lbs.	ozs.
Silica	4·23	1	$3\frac{2}{10}$
Phosphoric Acid	39·97	11	$5\frac{6}{10}$
Sulphuric Acid	·15	0	$0\frac{7}{10}$
Carbonic Acid	none	..	
Lime	1·32	0	$5\frac{9}{10}$
Magnesia	13·26	3	12
Peroxide of Iron	trace	..	
Potash	36·43	10	$5\frac{1}{10}$
Soda	4·62	1	5
Chloride of Sodium	none	..	
	99·98	28	$6\frac{8}{10}$

Specimen No. 39.—Hopeton Wheat.

From Mr. J. C. Morton.

[*Soil*, stiff clay; *subsoil*, clay; *geological formation*, Silurian or old red-sandstone; imperfectly drained; old arable land. After mangold-wurzel, 40 tons per acre. Drilled February, 1846; short straw; heavy crop; mown third week in August. Estimated yield 36 bushels an acre; straw strong, slightly mildewed; grain rather thin, 61½ lbs. per bushel.]

Average length of the straw . . 43 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain	1050	46·17		1000·0	
Straw	1060	46·62	53·83	1009·0	1165·1
Chaff	164	7·21		156·1	
Total	2274	100·00		2165·1	

Specific gravity of the grain . . 1·382

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain	12·00	1·63	1·81
Straw	13·30	4·27	4·92
Chaff	13·00	14·29	16·42

Produce and mineral matter of an acre:—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain	19	86	36
Straw	19	$105\frac{9}{10}$	$99\frac{6}{15}$
Chaff	3	$9\frac{6}{10}$	$49\frac{4}{15}$
Total	42	$89\frac{5}{10}$	184

Analysis of the ash of the grain:—

		Removed from an Acre. lbs.	ozs.
Silica	3·05	1	1
Phosphoric Acid	47·38	17	$0\frac{8}{10}$
Sulphuric Acid	none.	..	
Carbonic Acid	none.	..	
Lime	4·43	1	$9\frac{4}{10}$
Magnesia	9·32	3	$5\frac{6}{10}$
Peroxide of Iron	·35	0	2
Potash	32·05	11	$8\frac{5}{10}$
Soda	3·38	1	$3\frac{3}{10}$
Chloride of Sodium	..	..	
Total	99·96	35	15

Specimen No. 40.—Hopeton Wheat.

From Mr. J. C. Morton.

[*Soil*, sandy; *subsoil*, stone and clay; *geological formation*, Silurian; drained; 8 years in tillage. After carrots, 20 tons per acre. Drilled December, 1845; heavy crop; mown August 12th; carried August 20th. Estimated yield 42 bushels per acre; straw strong; grain good, 62 lbs. to the bushel.]

Average length of the straw . . 42 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain	1633	45·15		1000·0	
Straw	1732	47·89	54·85	1066·0	1220·1
Chaff	252	6·96		154·1	
Total	3617	100·00		2220·1	

Specific gravity of the grain . . 1·396

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain	12·00	1·71	1·94
Straw	11·80	4·07	4·61
Chaff	13·00	11·77	13·55

Produce and mineral matter of an acre:—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain	23	28	$44\frac{5}{10}$
Straw	24	$87\frac{3}{10}$	113
Chaff	3	$65\frac{2}{10}$	$47\frac{2}{10}$
Total	51	$68\frac{5}{10}$	$204\frac{7}{10}$

Analysis of the ash of the grain :—

			Removed from an Acre. lbs. ozs.
Silica	5·63	. .	2 8
Phosphoric Acid	43·98	. .	19 8
Sulphuric Acid	·21	. .	0 $1\frac{5}{10}$
Carbonic Acid	none.	. .	..
Lime	1·80	. .	0 $12\frac{8}{10}$
Magnesia	11·69	. .	5 $3\frac{7}{10}$
Peroxide of Iron	·29	. .	0 2
Potash	34·51	. .	15 $5\frac{6}{10}$
Soda	1·87	. .	0 $13\frac{3}{10}$
Chloride of Sodium	none.	. .	..
Total	99·98		44 $6\frac{4}{10}$

Analysis of the ash of the straw, with its proportion of chaff :—

			Removed from an Acre. lbs. ozs.
Silica	69·36	. .	111 $1\frac{7}{10}$
Phosphoric Acid	5·24	. .	8 $6\frac{3}{10}$
Sulphuric Acid	4·45	. .	7 $2\frac{2}{10}$
Carbonic Acid	none.	. .	..
Lime	6·96	. .	11 $2\frac{3}{10}$
Magnesia	1·45	. .	2 5
Peroxide of Iron	·73	. .	1 $2\frac{5}{10}$
Potash	11·79	. .	18 14
Soda	none.	. .	..
Chloride of Sodium	none.	. .	..
Total	99·98		160 $1\frac{8}{10}$

Specimen No. 41.—Hopeton Wheat.

From Mr. J. C. Morton.

[*Soil*, clay ; *subsoil*, stone and clay ; *geological formation*, Silurian ; drained. After carrots, 20 tons per acre. Drilled December, 1845 ; heavy crop ; *mown* August 12, carried August 20. Estimated yield 42 bushels per acre (this and the preceding specimen are from the same field, half being sand and half clay) ; straw strong, mildewed ; grain thin, 60 lbs. to the bushel.]

Average length of straw . . 45 inches.

Relation of grain, straw, and chaff :—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain	1382	41·29		1000·0	
Straw	1723	51·48	58·71	1246·0	1420·6
Chaff	242	7·23		174·6	
Total	3347	100·00		2420·6	

Specific gravity of the grain . . 1·393

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain	12·00	1·69	1·92
Straw	12·00	5·15	5·85
Chaff	11·00	12·14	13·64

Produce and mineral matter of an acre :—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain	22	56	$43\frac{2}{10}$
Straw	28	44	$161\frac{6}{10}$
Chaff	3	94	$53\frac{4}{10}$
Total	54	12	$258\frac{2}{10}$

Analysis of the ash of the grain :—

		Removed from an Acre. lbs.	ozs.
Silica	3·60	1	$8\frac{8}{10}$
Phosphoric Acid	49·22	21	$4\frac{2}{10}$
Sulphuric Acid	·18	0	$1\frac{2}{10}$
Carbonic Acid	none.	..	
Lime	2·51	1	$1\frac{3}{10}$
Magnesia	12·38	5	$5\frac{4}{10}$
Peroxide of Iron	·08	0	$0\frac{5}{10}$
Potash	30·32	13	$1\frac{4}{10}$
Soda	·07	0	$0\frac{4}{10}$
Chloride of Sodium	1·60	0	11
Total	99·96	43	$2\frac{2}{10}$

SPECIMEN No. 42.—HOPETON WHEAT.

From Mr. J. C. Morton.

Soil, silicious sand; *subsoil*, sand and rock; *geological formation*, old red-sandstone; drained; old arable land. After fair crop of clover (some earth of a clayey character was laid on the land in the autumn of 1845, at the rate of about 30 cubic yards per acre,—it evidently had an important influence on the crop). Drilled at 9 inches, February, 1846; heavy crop; mown third week in August. Estimated yield 40 bushels per acre; straw strong and flaggy; grain good, 62 lbs. to the bushel.]

Average length of the straw . . 44 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain	1207	42·3		1000·0	
Straw	1423	49·86	57·70	1167·0	1352·3
Chaff	224	7·84		185·3	
Total	2854	100·00		2352·3	

Specific gravity of the grain . . 1·391

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain	12·5	1·76	2·01
Straw	13·7	4·16	4·82
Chaff	11·5	10·36	11·70

Produce and mineral matter of an acre:—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain	22	16	$43\frac{6}{10}$
Straw	25	94	$120\frac{4}{10}$
Chaff	4	$11\frac{5}{10}$	$57\frac{6}{10}$
Total	52	$9\frac{5}{10}$	$221\frac{6}{10}$

Analysis of the ash of the grain:—

		Removed from an Acre. lbs.	ozs.
Silica	3·29	1	$6\frac{5}{10}$
Phosphoric Acid	44·44	19	6
Sulphuric Acid	trace.	. .	
Carbonic Acid	none.	. .	
Lime	8·21	3	$9\frac{2}{10}$
Magnesia	9·67	1	$3\frac{3}{10}$
Peroxide of Iron	·08	0	$0\frac{2}{10}$
Potash	32·14	14	1
Soda	2·14	0	$14\frac{9}{10}$
Chloride of Sodium	none.	. .	
Total	99·97	43	$9\frac{7}{10}$

Analysis of the ash of the straw and chaff:—

		Removed from an Acre. lbs.	ozs.
Silica	67·1	119	$6\frac{8}{10}$
Phosphoric Acid	7·05	12	$8\frac{7}{10}$
Sulphuric Acid	5·59	9	$15\frac{2}{10}$
Carbonic Acid	none.	. .	
Lime	4·44	7	$14\frac{4}{10}$
Magnesia	3·27	5	13
Peroxide of Iron	1·54	2	$11\frac{8}{10}$
Potash	10·03	17	$13\frac{6}{10}$
Soda	·85	1	8
Chloride of Sodium	none.	. .	
Total	99·97	177	$11\frac{5}{10}$

Specimen No. 43.—Red-straw White Wheat.

From Mr. J. C. Morton.

[*Soil*, silicious sandy loam; *subsoil*, sand; *geological formation*, old red-sandstone; drained; 7 years in tillage. After potatoes, about 20 sacks per acre; drilled at 9 inches, $1\frac{1}{2}$ bushel to acre, in October, 1845; promised 40 bushels an acre, but some of it blighted; mown last week of July. Estimated yield 32 bushels an acre; straw stiff; grain very good, 62 lbs. to the bushel.]

Average length of the straw . . 47 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain	1572	44·87		1000·0	
Straw	1651	47·13	55·13	1050·0	1228·3
Chaff	280	8·00		178·3	
Total	3503	100·00		2228·3	

Specific gravity of the grain . . 1·381

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	12·00 . .	1·72 . .	1·95
Straw . . .	12·70 . .	4·24 . .	4·85
Chaff . . .	12·50 . .	10·08 . .	11 52

Produce and mineral matter of an acre :—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain . . .	17	80 . .	$34\frac{1}{10}$
Straw . . .	18	$67\frac{2}{10}$ . .	$86\frac{3}{10}$
Chaff . . .	3	$17\frac{7}{10}$ . .	$35\frac{6}{10}$
Total . .	39	$52\frac{9}{10}$ . .	156

Analysis of the ash of the grain :—

		Removed from an Acre. lbs.	ozs.
Silica	2·14 . .	0	$11\frac{6}{10}$
Phosphoric Acid	49·58 . .	16	$4\frac{4}{10}$
Sulphuric Acid	·60 . .	0	$3\frac{2}{10}$
Carbonic Acid	none. . .	. .	
Lime	3·27 . .	1	$1\frac{7}{10}$
Magnesia	13·75 . .	4	$10\frac{9}{10}$
Peroxide of Iron	·23 . .	0	$1\frac{2}{10}$
Potash	29·75 . .	10	$2\frac{7}{10}$
Soda	·64 . .	0	$3\frac{3}{10}$
Chloride of Sodium	none. . .	. .	
Total	99·96	34	$0\frac{5}{10}$

Specimen No. 44.—Red-straw White Wheat.

From Mr. J. C. Morton.

[*Soil*, silicious sandy loam ; *subsoil*, sand and rock ; *geological formation*, old red-sandstone, naturally dry ; 7 years in tillage. After mangold-wurzel, 30 tons per acre. Drilled at 9 inches, January, 1846 ; good standing crop ; mown second week in August. Estimated yield 38 bushels per acre ; straw stiff ; grain good, 62 lbs. to the bushel.]

Average length of the straw . . 45 inches.

Relation of grain, straw, and chaff :—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	1200 . .	39·51	. .	1000·0	
Straw . . .	1593 . .	52·46	60·49 . .	1327·0	1530·2
Chaff . . .	244 . .	8·03	. .	203·2	
Total . .	3037	100·00		2530·2	

Specific gravity of the grain . . 1·392

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Grain	12·50	1·73	1·97
Straw	11·80	4·68	5·30
Chaff	14·00	13·78	16·02

Produce and mineral matter of an acre :—

	Produce. cwts.	Produce. lbs.	Mineral Matter. lbs.
Grain	21	4	$40\frac{7}{10}$
Straw	27	$102\frac{4}{10}$	$146\frac{3}{10}$
Chaff	4	$30\frac{7}{10}$	$65\frac{9}{10}$
Total	53	$25\frac{1}{10}$	$252\frac{9}{10}$

Analysis of the ash of the grain :—

		Removed from an Acre. lbs.	ozs.
Silica	2·63	1	1
Phosphoric Acid	47·44	19	5
Sulphuric Acid	none.	..	
Carbonic Acid	none.	..	
Lime	3·39	1	6
Magnesia	14·05	5	$11\frac{3}{10}$
Peroxide of Iron	·67	0	$4\frac{3}{10}$
Potash	29·91	12	$2\frac{7}{10}$
Soda	1·87	0	$12\frac{2}{10}$
Chloride of Sodium	none.	..	
Total	99·96	40	$10\frac{5}{10}$

Analysis of the ash of the straw and chaff :—

		Removed from an Acre. lbs.	ozs.
Silica	70·50	149	$7\frac{4}{10}$
Phosphoric Acid	5·77	12	$3\frac{7}{10}$
Sulphuric Acid	3·31	0	7
Carbonic Acid	none.	..	
Lime	3·53	7	8
Magnesia	3·29	7	0
Peroxide of Iron	·14	0	$4\frac{6}{10}$
Potash	12·76	27	1
Soda	·68	1	6
Chloride of Sodium	none.	..	
Total	99·98	211	$14\frac{7}{10}$

Specimen No. 45.—Red-Straw White Wheat.

From Mr. J. C. Morton.

[*Soil*, calcareous, brashy and shallow ; *subsoil*, carboniferous limestone rock : *geological formation*, carboniferous limestone ; naturally dry. After clover and rye-grass, not a heavy crop. Drilled at 9 inches, $1\frac{1}{2}$ bushels to the acre, November, 1845. Looked short in the straw and thin ; mown 2nd week in August. Estimated yield 30 bushels an acre ; straw strong ; grain good, 61 lbs. to the bushel.]

Average length of the straw . . 42 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	1285	48·9		1000·0	
Straw . . .	1095	41·7	51·1	852·5	1044·7
Chaff . . .	246	9·4		192·2	
Total . .	2626	100·0		2044·7	

Specific gravity of the grain . . . 1·362

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	11·50	1·61	1·81
Straw . . .	12·43	2·74	3·12
Chaff . . .	13·00	7·04	8·09

Produce and mineral matter of an acre:—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain . . .	16	38	$29\frac{5}{10}$
Straw . . .	13	104	$42\frac{7}{10}$
Chaff . . .	3	$15\frac{7}{10}$	$24\frac{7}{10}$
	33	$45\frac{7}{10}$	$96\frac{9}{10}$

Analysis of the ash of the grain:—

		Removed from an Acre. lbs.	ozs.
Silica	2·76	0	$13\frac{3}{10}$
Phosphoric Acid	47·38	13	$15\frac{5}{10}$
Sulphuric Acid	·07	0	$0\frac{2}{10}$
Carbonic Acid	none.	..	
Lime	6·87	2	2
Magnesia	11·46	3	6
Peroxide of Iron	·07	0	$0\frac{2}{10}$
Potash	30·13	8	14
Soda	1·25	0	$5\frac{7}{10}$
Chloride of Sodium . . .	..	..	
Total	99·99	29	$8\frac{9}{10}$

Analysis of the ash of the straw, with its proportion of chaff:—

		Removed from an Acre. lbs.	ozs.
Silica	71·49	47	8
Phosphoric Acid	3·37	2	4
Sulphuric Acid	2·28	1	8
Carbonic Acid	none.	..	
Lime	7·34	4	14
Magnesia	3·53	2	$5\frac{4}{10}$
Peroxide of Iron	1·11	0	$11\frac{7}{10}$
Potash	9·47	6	$4\frac{6}{10}$
Soda	1·39	0	$14\frac{7}{10}$
Chloride of Sodium . . .	none.	..	
Total	99·98	66	$6\frac{4}{10}$

Specimen No. 46.—Red-Straw White Wheat.

From Mr. J. C. Morton.

[*Soil*, clayey loam; *subsoil*, clay; *geological formation*, a member of the Silurian series, probably the Ludlow rock. Drained; 7 years in tillage. After good crop of clover, drilled at 9 inches, January, 1846. Crop very much laid; mown second week in August. Estimated yield 35 bushels an acre; straw stiff, grain good; 63 lbs.]

Average length of straw . . . . 46 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain . . .	1232	42·94		1000·0	
Straw . . .	1384	48·24	57·06	1123·0	1328·4
Chaff . . .	253	8·82		205·4	
	2869	100·00		2328·4	

Specific gravity of the grain . . . 1·413

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain . . .	11·00	1·60	1·80
Straw . . .	12·30	4·20	4·79
Chaff . . .	12·00	9·45	10·73

Produce of mineral matter of an acre:—

	Produce. cwts.	Produce. lbs.	Mineral Matter. lbs.
Grain . . .	19	77	$35\frac{3}{10}$
Straw . . .	22	12	104
Chaff . . .	2	$23\frac{5}{10}$	$23\frac{4}{10}$
	44	$0\frac{5}{10}$	$162\frac{7}{10}$

Analysis of the ash of the grain:—

		Removed from an Acre. lbs.	ozs.
Silica	3·89	1	6
Phosphoric Acid	46·79	16	8
Sulphuric Acid	none.	..	
Carbonic Acid	none.	..	
Lime	1·15	0	$6\frac{4}{10}$
Magnesia	13·39	4	$11\frac{5}{10}$
Peroxide of Iron	·91	0	5
Potash	30·02	10	$9\frac{4}{10}$
Soda	3·82	1	$5\frac{4}{10}$
Chloride of Sodium . . .	none	..	
Total	99·97	35	$3\frac{7}{10}$

Analysis of the ash of the straw:—

		Removed from an Acre. lbs.	ozs.
Silica	63·89	65	$14\frac{7}{10}$
Phosphoric Acid	2·75	2	$13\frac{7}{10}$
Sulphuric Acid	3·09	4	$0\frac{4}{10}$
Carbonic Acid	..	..	
Lime	7·42	7	$6\frac{4}{10}$
Magnesia	1·94	2	0
Peroxide of Iron	·45	0	$7\frac{4}{10}$
Potash	17·98	18	11
Soda	2·47	2	9
Chloride of Sodium	..	..	
Total	99·98	103	$14\frac{6}{10}$

Analysis of the ash of the chaff:—

		Removed from an Acre. lbs.	ozs.
Silica	81·22	19	0
Phosphoric Acid	4·31	1	0
Sulphuric Acid	none.	..	
Carbonic Acid	none.	..	
Lime	1·88	0	7
Magnesia	1·27	0	$4\frac{6}{10}$
Peroxide of Iron	0·37	0	$1\frac{3}{10}$
Potash	9·14	2	2
Soda	1·79	0	$6\frac{5}{10}$
Chloride of Sodium	none.	..	
Total	99·98	23	$5\frac{4}{10}$

Specimen No. 47.—Red-Straw White Wheat.

From Mr. J. C. Morton.

[*Soil*, calcareous and silicious sand mixed with clay; *subsoil*, half the field rock and half deep clay; *geological formation*, Ludlow or Wenlock rock, Silurian; drained; 7 years in arable, after carrots 15 tons per acre. Drilled at 9 inches, Dec. 1845; a good deal laid; *mown* second week in August. Estimated yield 40 bushels an acre; straw stiff; grain good 63 lbs. to the bushel.]

Average length of the straw . . 42 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain	1324	39·83		1000	
Straw	1739	52·32	60·17	1313	1510
Chaff	261	7·85		197	
Total	3324	100·00		2510	

Specific gravity of the grain . . 1·377

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain	11·00	1·90	2·13
Straw	13·19	7·36	8·47
Chaff	11·50	15·88	17·94

Produce and mineral matter of an acre:—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain	22	56	$47\frac{9}{10}$
Straw	29	60	$243\frac{4}{10}$
Chaff	4	$48\frac{4}{10}$	$78\frac{7}{10}$
Total	56	$52\frac{4}{10}$	370

Analysis of the ash of the grain:—

		Removed from an Acre. lbs.	ozs.
Silica	2·17	1	$0\frac{4}{10}$
Phosphoric Acid	46·61	22	$5\frac{1}{10}$
Sulphuric Acid	·44	0	$3\frac{3}{10}$
Carbonic Acid	none.	..	
Lime	5·05	2	$6\frac{5}{10}$
Magnesia	14·22	6	13
Peroxide of Iron	·09	0	$0\frac{7}{10}$
Potash	29·17	13	$15\frac{5}{10}$
Soda	2·20	1	$0\frac{8}{10}$
Chloride of Sodium	none.	..	
Total	99·95	48	$0\frac{3}{10}$

Specimen No. 48.—Red-Straw White Wheat.

From Mr. J. C. Morton.

[*Soil*, calcareous clay; *subsoil*, clay and rock; *geological formation*, dolomitic conglomerate (magnesian limestone); naturally pretty dry; after turnips, 20 tons per acre. Drilled at 9 inches, Nov. 1845; promised a good crop; *mown* second week in August. Estimated yield 34 bushels an acre; straw stiff; grain good, $62\frac{1}{2}$ lbs. per bushel.]

Average length of the straw . . 36 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain	1141	46·25		1000·0	
Straw	1120	45·40	53·75	981·6	1162·0
Chaff	206	8·35		180·4	
Total	2467	100·00		2162·0	

Specific gravity of the grain . . 1·388

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain	12·00	1·73	1·96
Straw	11·63	4·95	5·60
Chaff	12·50	9·63	11·00

Produce and mineral matter of an acre:—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain	18	109	$36\frac{7}{10}$
Straw	18	71	$103\frac{2}{10}$
Chaff	3	$48\frac{3}{10}$	37
Total	41	$4\frac{3}{10}$	$176\frac{9}{10}$

Analysis of the ash of the grain:—

		Removed from an Acre. lbs.	ozs.
Silica	2·05	0	12
Phosphoric Acid	46·99	17	$3\frac{8}{10}$
Sulphuric Acid	·24	0	$1\frac{4}{10}$
Carbonic Acid	none.	..	
Lime	6·78	2	$7\frac{7}{10}$
Magnesia	12·76	4	$10\frac{9}{10}$
Peroxide of Iron	2·32	0	$13\frac{6}{10}$
Potash	26·70	9	$12\frac{8}{10}$
Soda	2·12	0	$12\frac{4}{10}$
Chloride of Sodium	none.	..	
Total	99·96	36	$10\frac{6}{10}$

Analysis of the ash of the straw and chaff:—

		Removed from an Acre. lbs.	ozs.
Silica	66·13	92	$8\frac{5}{10}$
Phosphoric Acid	8·85	12	$6\frac{4}{10}$
Sulphuric Acid	2·23	3	2
Carbonic Acid	none.	..	
Lime	6·82	9	$8\frac{6}{10}$
Magnesia	3·62	5	$1\frac{5}{10}$
Peroxide of Iron	·54	0	12
Potash	11·76	16	8
Soda	none.	..	
Chloride of Sodium	none.	..	
Total	99·95	139	15

Specimen No. 49.—Red-Straw White Wheat.

From Mr. J. C. Morton.

[*Soil*, adhesive loam; *subsoil*, clay; *geological formation*, one of the upper beds of the Silurian; drained; 8 years in tillage, after clover depastured. Drilled $1\frac{1}{2}$ bushels an acre in Dec. 1845, promising a fair crop; *mown* second week in August. Estimated yield 34 bushels an acre; straw strong and stiff; grain good, 61 lbs.]

Average length of the straw . . 51 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.		Grain as 1000.	
Grain	1054	41·57		1000·0	
Straw	1228	48·43	58·43	1165·0	1405·5
Chaff	254	10·00		240·5	
	2536	100·00		2405·5	

Specific gravity of the grain . . 1·386

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain	12·0	1·71	1·94
Straw	12·5	5·07	5·79
Chaff	12·5	11·27	12·88

Produce and mineral matter of an acre:—

	Produce. cwts.	lbs.	Mineral Matter. lbs.
Grain	19	68	$37\frac{5}{10}$
Straw	22	94	$129\frac{7}{10}$
Chaff	4	$50\frac{7}{10}$	$55\frac{2}{10}$
Total	46	$100\frac{7}{10}$	$222\frac{4}{10}$

Specimen No. 50.—Old Red Lammas Wheat.

From Mr. Philip Pusey.

[*Soil*, highly calcareous; *subsoil*, the "chalk malm," half way up the escarpment of the chalk hills near Wantage. (This and similar soils at Newmarket, at Selborne in Hampshire, and in Yorkshire, are famous for seed wheat—Mr. Pusey.) After seeds; the land rather wet in winter; grain good; 61 lbs. to the bushel.]

Specific gravity of the grain . . 1·387

Per centage of water and ash in the grain:—

Water.	Ash.	Ash calculated on dry substance
12·5	1·84	2·10

Analysis of the ash of the grain:—

Silica	5·46
Phosphoric Acid	40·57
Sulphuric Acid	0·32
Carbonic Acid	none.
Lime	3·21
Magnesia	9·56
Peroxide of Iron	2·06
Potash	34·26
Soda	4·53
Chloride of Sodium	trace.
Total	99·97

Of the following specimens of wheat, the grain only has come into our possession, and even of this we can give no history. We subjoin, however, the few particulars which we have obtained respecting them.

Specimen.		Specific Gravity.	Water.	Ash.	Ash calculated on dry substance.
51*	Mummy Wheat	1·376	11·5	1·89	2·13
52	Hopeton Wheat	1·385	12·00	1·72	1·95
53	April Wheat	1·390	12·00	1·92	2·18
54	Essex Rough-Chaff Wheat. .	1·382	11·00	1·74	1·95
55	Essex Red Wheat	1·349	12·00	1·54	1·75
56	Fenton Wheat	1·360	11·00	1·77	1·99
57	Rostock Wheat	1·366	11·00	1·46	1·64
58	Spanish Wheat	1·364	13·00	1·65	1·90
59	Dantzic Wheat	1·342	11·00	1·71	1·92
60	Ditto	1·339	10·00	1·46	1·62
61	Ditto	1·344	12·00	1·47	1·67
62	Rostock	1·364	10·00	1·61	1·78

BARLEY.

Specimen No. 63.—Specimen of Barley (variety unknown).

From the Rev. A. Huxtable.

[*Soil*, thin, calcareous; *subsoil*, chalk; *geological formation*, the upper chalk; does not need draining; two years in tillage. After swedes, raised by 2 cwt. of guano; about one-fourth of the bulbs and leaves fed off by sheep. Sown broadcast, April, 1845. The crop looked poor. Estimated yield 30 bushels per acre (outside quantity); grain middling quality, 50 lbs. to the bushel.]

Per centage of water and ash in the grain :—

Water.	Ash.	Ash calculated on dry substance.
12·00	2·14	2·43

Analysis of the ash of the grain :—

		Removed from an Acre. lbs. ozs.
Silica	30·68	9 13$\frac{4}{10}$
Phosphoric Acid	28·53	9 2$\frac{5}{10}$
Sulphuric Acid	1·91	0 9$\frac{8}{10}$
Carbonic Acid	none.	. .
Lime	1·65	0 8$\frac{1}{10}$
Magnesia	7·26	2 5$\frac{3}{10}$
Peroxide of Iron	2·13	0 10$\frac{9}{10}$
Potash	21·14	6 12$\frac{5}{10}$
Soda	none.	. .
Chloride of Sodium	1·01	0 5$\frac{1}{10}$
Chloride of Potassium	5·65	1 13
	99·96	32 0$\frac{9}{10}$

* Specimens 51, 52, 53, from Mr. Zacchary; 54, 55, 57, 59, 60, from Mr. Farmer of Enfield; 58, 61, 62, Mr. Coleman; 56, Mr. Fenton.

Specimen No. 64.—Chevalier Barley.

Obtained for seed from Messrs. Gibbs.

Specific gravity of the grain . . 1·260

Per centage of water and ash in the grain :—

Water.	Ash.	Ash calculated on dry substance.
10·00	2·25	2·50

Analysis of the ash of the grain :—

Silica	32·73
Phosphoric Acid	31·69
Sulphuric Acid	0·79
Carbonic Acid	none.
Lime	1·48
Magnesia	7·45
Peroxide of Iron	0·51
Potash	20·77
Soda	4·56
Chloride of Sodium	none.
Total	99·98

Specimen No. 65.—Chevalier Barley.

The produce of seed, Specimen 64.

[The seed was planted by way of experiment very late in the season, and on thin poor land belonging to this College. After potatoes; the crop never looked well, and its amount was not ascertained.]

Specific gravity of the grain . . 1·234

Per centage of water and ash in the grain :—

Water.	Ash.	Ash calculated on dry substance.
16·00	2·43	2·82

Analysis of the ash of the grain :—

Silica	23·60
Phosphoric Acid	26·01
Sulphuric Acid	2·72
Carbonic Acid	none.
Lime	2·79
Magnesia	8·67
Peroxide of Iron	0·09
Potash	27·43
Soda	0·05
Chloride of Sodium	8·60
Total	99·96

Specimen No. 66.—Moldavian Barley.

Obtained for seed from Messrs. Gibbs.

Specific gravity of the grain . . 1·268

Per centage of water and ash in the grain :—

Water.	Ash.	Ash calculated on dry substance.
11·00	2·12	2·38

Analysis of the ash of the grain :—

Silica	24·56
Phosphoric Acid	28·64
Sulphuric Acid	0·27
Carbonic Acid	none.
Lime	1·21
Magnesia	10·17
Peroxide of Iron	1·02
Potash	31·55
Soda	1·06
Chloride of Sodium	1·47
Total	99·94

Specimen No. 67.—Moldavian Barley.

The produce of seed, Specimen 66.

Per centage of water and ash in the grain :—

Water.	Ash.	Ash calculated on dry substance.
16·00	2·31	2·75

Specimen No. 68.—Awn of Chevalier Barley.

Per centage of water and ash in the grain :—

Water.	Ash.	Ash calculated on dry substance.
15·00	12·10	14·23

Analysis of the ash of the grain :—

Silica	70·77
Phosphoric Acid	1·99
Sulphuric Acid	2·99
Carbonic Acid	1·98
Lime	10·36
Magnesia	1·26
Peroxide of Iron	1·46
Potash	7·70
Soda	0·36
Chloride of Sodium	1·10
	99·97

Specimen No. 68.—Hopeton Oats.

From the Rev. A. Huxtable.

[*Soil*, thin, calcareous; *subsoil*, chalk; *geological formation*, the upper chalk; naturally dry; two years in tillage. The two previous crops were swedes, raised by guano; one-fourth of the bulbs and all the tops being fed off by sheep. Sown broadcast, March, 1845; crop was splendid; very fine straw; *mown* August, 1845. Estimated yield 56 bushels an acre; good quality, 42 lbs. a bushel.]

Per centage of water and ash in the grain :—

Water.	Ash.	Ash calculated on dry substance.
9·5	2·27	2·50

Analysis of the ash of the grain :—

		Removed from an Acre. lbs.	ozs.
Silica	38·48	20	8
Phosphoric Acid	26·46	14	$1\frac{9}{10}$
Sulphuric Acid	1·10	0	$9\frac{3}{10}$
Carbonic Acid	..	..	
Lime	3·54	1	$14\frac{3}{10}$
Magnesia	7·33	3	$14\frac{5}{10}$
Peroxide of Iron	0·49	0	$3\frac{7}{10}$
Potash	17·80	9	8
Soda	3·84	2	0
Chloride of Sodium	0·92	0	$7\frac{8}{10}$
	99·96	53	$3\frac{4}{10}$

Specimen No. 69.—Potato Oats.

Obtained for seed from Messrs. Gibbs.

Specific gravity of the grain . . 1·191

Per centage of water and ash in the grain :—

Water.	Ash.	Ash calculated on dry substance
10·5	2·45	2·73

Analysis of the ash of the grain :—

Silica	50·03
Phosphoric Acid	18·87
Sulphuric Acid	0·10
Carbonic Acid	none.
Lime	1·31
Magnesia	8·25
Peroxide of Iron	0·27
Potash	19·70
Soda	1·35
Chloride of Sodium	0·07
Total	99·95

Specimen No. 70.—Potato Oats.

Produce of Specimen 69, and grown in the same circumstances as Specimens 65 and 67.

Per centage of water and ash in the grain:—

Water.	Ash.	Ash calculated on dry substance.
11·00	3·74	4·20

Specimen No. 71.—Poland Oats.

Obtained for seed from Messrs. Gibbs.

Specific gravity of the grain . . 1·152

Per centage of water and ash in the grain:—

Water.	Ash.	Ash calculated on dry substance.
11·00	2·65	2·97

Analysis of the ash of the grain:—

Silica	41·86
Phosphoric Acid	14·49
Sulphuric Acid	1·74
Carbonic Acid	none.
Lime	2·65
Magnesia	8·26
Peroxide of Iron	0·69
Potash	24·30
Soda	5·51
Chloride of Sodium	0·45
Total	99·95

Specimen No. 72.—Poland Oats.

The produce of seed, Specimen 71.

[The remarks made concerning Specimen 65 apply also to this.]

Per centage of water and ash in the grain:—

Water.	Ash.	Ash calculated on dry substance.
13·00	3·31	3·80

Analysis of the ash of the grain:—

Silica	43·20
Phosphoric Acid	16·19
Sulphuric Acid	4·01
Carbonic Acid	·59
Lime	8·35
Magnesia	5·90
Peroxide of Iron	·09
Potash	16·35
Soda	5·27
Chloride of Sodium	none.
Total	99·95

Specimen No. 73.—Oats.

College Farm.

Per centage of water and ash in the grain:—

Water.	Ash.	Ash calculated on dry substance.
12·00	2·75	3·12

Analysis of the ash of the grain:—

Silica	49·44
Phosphoric Acid	21·53
Sulphuric Acid	·13
Carbonic Acid	none.
Lime	4·22
Magnesia	8·82
Peroxide of Iron	·36
Potash	13·97
Soda	1·50
Chloride of Sodium	none.
Total	99·95

Specimen No. 74.—Chaff of Oats.

Of Specimen 73.

Per centage of water and ash:—

Water.	Ash.	Ash calculated on dry substance.
15·00	7·84	9·22

Analysis of the ash:—

Silica	59·92
Phosphoric Acid	6·26
Sulphuric Acid	2·48
Carbonic Acid	·21
Lime	8·65
Magnesia	2·58
Peroxide of Iron	1·42
Potash	13·12
Soda	4·06
Chloride of Sodium	1·24
Total	99·94

Specimen No. 75.—Specimen of Rye.

From Mr. Robins of Kidderminster.

Length of straw . . . 52 inches.

Relation of grain, straw, and chaff:—

	Actual Quantities.	Per Centage.	Grain as 1000.
Grain	1714	40	1000
Straw, Chaff	2580	60	1500
Total	4294		

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Grain	15·00	1·36	1·60
Straw	..	3·13	..

Analysis of the ash of the grain:—

Silica	9·22
Phosphoric Acid	39·92
Sulphuric Acid	·17
Carbonic Acid	none.
Lime	2·61
Magnesia	12·81
Peroxide of Iron	1·04
Potash	33·83
Soda	·39
Chloride of Sodium	none.
Total	99·99

Having now separately described each specimen of wheat, &c. that has come under our notice, we will proceed to point out, as far as we have been able to discover them, the conclusions which are to be drawn from the data before us; at the same time remarking, that as our results will appear periodically in the Journal, no single section of the Report will be complete in itself, but must be taken only as a statement of *present* progress. First, then, of wheat:—

The object of the present inquiry certainly does not require that we should go out of our way to obtain, respecting different crops, information which, however desirable it may otherwise be, is not immediately connected with the *mineral* composition of plants; but it will readily be allowed that in ascertaining the mineral wants and peculiarities of any particular crop, not only the quantity and composition of the ash must be determined, but the relative amount of the different parts of the plants whose ash is analyzed; for we are desirous of discovering not only the character of those mineral ingredients which, for the growth of any crop, the soil must possess, but also the quantity of them which will be removed by a given amount of produce, and which must be returned to the land to restore its fertility.

The relative proportion of grain, straw, and chaff, in every specimen of wheat, is then an indispensable part of its history, and as such we have taken particular care in determining it. We have before mentioned in what manner this has been effected.

But although foreign to the immediate purpose of this Report, we cannot allow the information so obtained concerning the several parts of wheat, irrespective of their mineral composition, to pass without notice.

The produce in grain is of course dependent upon a great variety of circumstances, such as the general fertility of the land,

the character of the season, locality, aspect, climate, treatment, &c., and we cannot hope to add anything to what is already known on this highly important subject. We may mention that the mean produce, over more than 40 specimens, has been found to be 28 bushels of grain, of a mean weight of 61 lbs. to the bushel.

The amount of straw in comparison with that of grain, is also in the same way very closely connected with the varying conditions in which the crop has existed; but upon this individual question our results would seem to throw some light. We are not ignorant that many careful observers have endeavoured to discover the general relationship in quantity which the straw of wheat bears to the grain; but we think that these determinations have seldom hitherto been conducted over so large a number of specimens, in such varying conditions as regards soil and cultivation, or with the same amount of analytical accuracy as the present.

Granted that weighings on the large scale are in many respects, when carefully conducted, capable of a nearer approach to absolute truth, than the results which a chemist obtains by the help of his balance—that is to say, when his errors, although of excessively trifling amount in themselves, are by multiplication into tons instead of grains magnified to a very great extent; but this reasoning only applies to those determinations on the large scale where every circumstance is taken into account. Now the straw of wheat is not (as will presently be seen) all solid matter, but contains more than a tenth part of its weight of water. It is true that the quantity of water in the straw is not subject to much deviation, being comprised within very narrow limits, which we need not at present mention; but the water which is natural to it—so to speak—it never loses, except by the application of artificial heat much higher than that produced by natural agencies, such as the rays of the sun or the warm atmosphere. On the other hand, although straw has always a certain amount of this natural water, it may contain a large additional quantity of accidental moisture. In other words, it may be really wet. Now in ascertaining the proportion of straw to grain on the large scale, this circumstance cannot fail of proving a fertile source of error; for supposing that a quantity of wheat be removed for weighing from the field, who is to say (without careful experiment) how much accidental water it contains, and how far such calculations will be interfered with in consequence?

Even in the rick, where a large quantity of straw is closely packed together, although it is known to dry to a considerable extent, we can hardly suppose that it ever attains the condition of dryness which is natural to it. But it may be argued, that we

are equally open to the same objection on the small scale—that our specimens may be wet as well as larger quantities; but were it so we should know it, for in each case we have ascertained the water contained in the specimen: that they should be found very similar in this respect is not to be wondered at, and is no proof of the constant state, as regards moisture, of a whole crop—for our specimens, being small, soon dry in a warm atmosphere, and, with free exposure to the air, to the extent which is natural to them.

The method usually adopted of weighing large quantities of grain and straw to determine their relative proportion is, we consider, open to much objection in consequence of the varying condition of the straw as to dryness.

The chaff of wheat is also capable of absorbing and retaining, unless freely exposed to the air, a considerable amount of moisture, and would materially tend in this way to increase the apparent amount of straw and chaff in relation to grain.

In pointing out these circumstances as likely to influence the accuracy of determinations on the large scale, we do not of course at all include those other sources of error which imperfect weighing apparatus and carelessness, or indifference on the part of those intrusted with the duty of ascertaining these particulars, would introduce. The general impression with practical men, with regard to the relative weight of grain and straw, would seem to be, that the latter is ordinarily double the former—at least such has been the answer which our inquiries on this point have usually elicited. In this statement they of course include the chaff, and speak of the actual quantity of straw removed from the land, without reference to the stubble which is left behind.

We will shortly allude to our own results obtained on the crops of the present harvest, premising that we are well aware that the dryness of the season, whilst it has had a favourable effect upon the wheat as a grain crop, has at the same time rendered the straw shorter, and consequently less in weight than in average years.*

* In the account of the specimens we have given the relation of grain, straw, and chaff, in three different forms. By the insertion of the actual quantities in the weighings, we wish to show how much wheat in each case has been operated upon. The *per centage* is given as the ordinary and familiar method. We, however, prefer considering the grain as a fixed quantity, as 1000 for instance, and referring the weight of straw and chaff to this number; in this way the weight of straw and chaff of any one specimen is strictly comparable with that of another.

The per centage is open to objection from there being three numbers; the alteration of any two causes the third to deviate, although in reality perhaps constant—this will at once be seen by reference to specimens 3, 23, 32, 49.

The following table exhibits the weight of straw and chaff in reference to grain, in 11 specimens of wheat from the farm of this College—all of them, except No. 3 and No. 8, being reaped.

TABLE I.—*Relation of Grain, Straw, and Chaff of* 11 *Specimens of Wheat from the College Farm.*

Grain as 1000.

No. of Specimen.	Variety of Specimen.	Soil.	Length of Straw.	Weight of Straw.	Weight of Chaff.	Weight of Straw and Chaff.
			Inches			
1	Hopeton	Stonebrash and clay	36	1107·2	204·3	1311·5
2	Hopeton	Stonebrash	38	986·8	206·1	1192·9
3	April Wheat	Stonebrash	28	996·8	278·5	1275·3
4	Spring Wheat	Calcareous clay	34	962·9	219·0	1181·9
5	Bristol Red	Brash and clay	38	955·0	216·0	1171·0
6	Clover's Red	Stonebrash	40	978·1	208·4	1186·5
7	Red-Chaff Dantzic	Brash and clay	38	1013·2	184·6	1197·8
8	Piper's Thickset	Ditto	29	928·0	173·0	1101·0
9	White Chaff	Ditto	36	827·3	154·7	982·0
10	Hopeton	Ditto	40	1163·3	194·3	1355·0
11	Spalding	Stonebrash	38	988·5	222·6	1211·1

With the exception of two specimens, we do not observe any very great dissimilarity in the numbers here given—we allude to April wheat (No. 3) and white-chaff wheat (No. 9). In the first, which is a bearded wheat, the chaff, including the awn, is necessarily high; in the white-chaff wheat the straw and chaff are both very low. In taking the mean of the 11 wheats, the deviation in these two specimens is of little importance, as it occurs in opposite senses, the one destroying the effect of the other.

The mean weight referred to grain as 1000 is—

For the straw . . .	991·3
„ chaff . . .	205·6
Straw and chaff .	1196·9

Mean length of the straw, 36 inches.

We may next collect in a table the results of an estimation on five specimens of Hopeton wheat from Mr. Morton.

TABLE II.—*Relation of Grain, Straw, and Chaff in* 5 *Specimens of Hopeton Wheat.*

Grain as 1000.

No. of Specimen.	Variety.	Soil.	Length of Straw.	Weight of Straw.	Weight of Chaff.	Weight of Straw and Chaff.
			Inches			
38	Hopeton	Gritty silicious sand	38	926·9	148 3	1075·2
39	Ditto	Stiff clay	43	1009·0	156·1	1165·1
40	Ditto	Sandy	42	1066·0	154·1	1220.
41	Ditto	Clay	45	1246·0	174·6	1420·6
42	Ditto	Silicious sand	44	1167·0	185·3	1352·3

The mean of these results will be found to be—

For the straw	1083·
„ chaff	163·6
For the straw and chaff	1246·6

Mean length of the straw, 42·4 inches.

In these specimens the mean length of the straw and its weight in proportion to the grain are both greater than in those of the other series from the College farm: this is evidently due in a great measure to the method of collecting the crops, Mr. Morton's all being mown, and the others, with two exceptions, reaped.

TABLE III.—*Proportion of Grain, Straw, and Chaff in 7 Specimens of Red-Straw White Wheat from Mr. Morton.*

Grain as 1000.

No. of Specimen.	Variety.	Soil.	Length of Straw.	Weight of Straw.	Weight of Chaff.	Weight of Straw and Chaff.
			Inches			
43	Red-Straw White .	Silicious sandy loam .	47	1050·0	178·3	1228·3
44	Ditto . .	Ditto . .	45	1327·0	203·2	1530·2
45	Ditto . .	Calcareous, brashy, and shallow . .	42	852·5	192·2	1044·7
46	Ditto . .	Clay loam . . .	46	1123·0	205·4	1328·4
47	Ditto . .	Calcareous and silicious sand with clay	42	1313·0	197·0	1510·0
48	Ditto . .	Calcareous clay .	36	981·6	180·4	1162·0
49	Ditto . .	Adhesive loam . .	52	1165·0	240·5	1405·5

The specimens give a mean—

For the straw	1116·
„ chaff	199·6
Straw and chaff .	1315·6

Mean length of straw, 44·3 inches.

It will be seen that the highest number in the series does not much exceed 1500 of straw and chaff to 1000 of grain.

The chaff of the red-straw white wheat, it will be observed, is larger in quantity than that of the Hopeton. This is probably a peculiarity of the variety. How far may this variation in the chaff affect the ripening of the two varieties?

We next give a table of the same kind, embracing 15 specimens of different kinds of wheat received from Sir J. Johnstone. We have purposely omitted from the list a specimen of red Britannia (Spec. 22), which is so different in the proportion of straw, as greatly to affect the mean, if it were taken into the calculation. Sir John Johnstone's specimens were all bagged, and therefore

the quantities represent very nearly the total straw; indeed in six cases the entire plant, including the root, was sent to us, and the estimation of straw effected after removing the latter at a distance of an inch and a half from the extremity.

TABLE IV.—*Proportion of Straw and Chaff in* 15 *Specimens of Wheat from Sir John Johnstone.*

Grain as 1000.

No. of Specimen.	Variety.	Soil.	Length of Straw.	Weight of Straw.	Weight of Chaff.	Weight of Straw and Chaff.
			Inches			
13	Creeping Wheat .	Clay and grit . .	39	957·7	188·0	1145·7
14	Talavera . . .	Ditto . .	44	1175·0	164·9	1339·9
15	White Wheat . .	Ditto . .	40	1184·0	161·4	1345·4
16	Talavera . . .	Calcareous loam. .	38	1155·0	174·9	1329·9
17	Creeping Wheat .	Ditto . .	39	1071·0	116·3	1187·3
18	Ditto . .	"Hazle loam" . .	42	1143·0	198·8	1341·8
19	Ditto . .	Heavy tough clay .	42	1032·0	165·8	1197·8
20	Talavera . . .	Tough clay . .	43	1068·0	176·1	1244·1
21	Hammond's Wheat .	Free clay loam . .	40	932·4	191·2	1123·6
23	Red Wheat . .	Weak clay loam. .	38	919·3	242·9	1162·2
24	White Wheat . .	Weak sandy clay .	41	1009·0	178·2	1187·2
25	Creeping Wheat .	Red clay . . .	40	981·0	179·5	1160·9
26	Ditto . .	Clay and sand . .	44	1272·0	179·0	1451·0
27	Ditto . .	Ditto . .	45	1279·0	185·6	1464·6
28	Ditto . .	Calcareous rubble .	45	1192·0	181·1	1373·1

Of the 15 specimens here given, only in one instance does the united weights of straw and chaff reach 1400; and the greater number of specimens fall far short of this amount.

The mean of the whole is—

For the straw . . .	1091·4
,, chaff . . .	178·9
Straw and chaff .	1270·3

Mean length of straw, 41·3 inches.

Let us compare the mean of all these specimens from different localities.

TABLE V.—*Mean Proportion of Straw and Chaff to Grain.*

	Length of Straw.	Straw.	Chaff.	Straw and Chaff.
	Inches.			
11 Specimens from College Farm . .	36·0	991·3	205·6	1196·9
12 Specimens from Mr. Morton . . .	43·3	1099·5	181·6	1281·1
15 Specimens from Sir J. Johnstone . .	41·3	1091·4	178·9	1270·3

Taking the mean of all these, we shall obtain the following numbers:—

For the straw . . .	1060·7
„ chaff	188·7
For the straw and chaff .	1249·4

Mean length of the straw, 40·2 inches.

It would thus appear, from a careful examination of 38 specimens collected promiscuously, that the straw and chaff together never exceed 1500, the grain being taken as 1000—or, in other words, that the former are, at the highest computation, one and a half times the weight of the latter, and in these particular cases the length of the straw is very considerable, and certainly beyond the average of this, if not of most other seasons. As, however, in by far the greater number of cases the proportion of straw, including the chaff, falls very far short of this, we have every reason to believe that the mean which we have obtained rightly represents the relation of straw and chaff to grain this year. The number 1250 of course gives one-fourth part more in weight, or about 17 cwt. of straw and 3 cwt. of chaff to 30 bushels of wheat at 61 lbs. We may perhaps be excused for dwelling upon a subject which cannot but be of interest to every one engaged in agricultural pursuits. Upon it depend most important calculations with regard to the quantity of fodder and litter at the farmer's disposal for any one year. It is only by considering the difference on the large scale that it assumes all the importance which it deserves.

On a farm of 400 acres of ordinary fertility, and cultivated on the four-course system, we might fairly consider that the average produce would amount to 28 bushels an acre of 61 lbs. to the bushel. On the calculation of the proportion of straw and chaff already deduced from our experiments, their united weight from the 100 acres (the grain being in weight 75¾ tons) would amount to rather more than 95¼ tons, including 14¾ tons of chaff. Were, however, the weight of straw and chaff to be, as is supposed, at any time equal to twice that of the grain, instead of 95¼, the quantity would be 152 tons. Surely this must make a most material difference in farm arrangements.

At the same time we must in fairness remark, that all observers agree in ascribing to the character of the season the most marked influence on the quantity of straw in relation to grain. Boussingault* mentions crops grown at Bechelbron in two consecutive years, which differed most extraordinarily in this respect.

In the first year (1840-41) the season was very wet; the second

* Rural Economy, 1 vol.

(1841-42) was remarkable for extreme drought. In these opposite conditions the weight of straw to grain was—

In 1840–41	as 100 to 40.
In 1841–42	as 100 to 90.

Converting these numbers into others which may be compared with our own, we have—

	Grain. Straw.
In 1840–41	1000 to 4160·2
In 1841–42	1000 to 1116·0

The latter number very nearly approaches our own mean for this year (1250); the other instance exhibits a most extraordinary deviation.

Boussingault states the ordinary relation of straw to grain at Bechelbron to be as 100 to 38 (or as 2631, grain being taken at 1000), and quotes in support of this being a probable average the following results of other continental observers:—

For 100 of straw—			Or Grain as 1000.
Thaer . .	gives . .	50 of grain . . .	2000 straw.
Podewils .	„ . .	35 „ . . .	2857 „
Berger . .	„ . .	41 „ . . .	2292 „
Block . .	„ . .	33 „ . . .	3030 „
Dierexen .	„ . .	39 „ . . .	2564 „
Schwertz .	„ . .	44 „ . . .	2272 „

It is not stated whether the chaff is included in the calculation, but we suppose that it is. In the back numbers of the Journal of this Society will be found many accounts of the estimation of straw and grain of wheat, in which the proportion of straw and chaff to grain is generally found to be between 1½ and 2½ that of the grain.

If, then, our results merit confidence, they would plainly prove either that the straw of this year is exceedingly small in quantity, or if (as we believe) its quantity does not fall far short of average years, that the proportion of straw to grain is usually very much overstated. It will presently be seen in what respect this conclusion is important in respect to the mineral matters of the wheat plant.

The quantity of chaff in wheat does not, as far as we can discover, depend upon the amount of straw, but bears a general though perceptible relation to the grain. To the latter it stands in the proportion of 1 to 5½ on an average of 1 cwt. of chaff to every 10 bushels of wheat.

Both straw and chaff are found in some cases to present singular deviations from the usually observed proportions: this is peculiarly the case in Piper's thickset wheat, Spec. 32, where the straw does not much exceed the half of the weight of the grain—the chaff, however, remaining constant.

We do not observe that the soil has exercised much influence on the quantities of straw and chaff—the average of clays, of sandy and calcareous soils, being in our experiments very similar.

Of the specific gravity of the grain we have before spoken; but

we desire now more distinctly to point out the connection which exists between it and the value of different specimens of wheat.

The specific gravity of wheat, we have said, is its true weight, with which no peculiarity of shape or size of the grains, no dampness or roughness of the skin, can interfere. Every farmer knows that the weight per bushel is most materially influenced by these circumstances, and, making allowances for them, is accustomed to consider it as a sure criterion of the value of the sample. It is known that the strength of flour and its fitness for making good bread is due to the gluten contained in it, and corresponds to a considerable extent with the weight per bushel—the greater the weight per bushel the better the flour. But setting aside the accidental differences of skin which are the result of threshing in damp weather, &c., and taking two wheats as nearly alike as possible in this respect, the question to decide will be—Is the wheat of most pounds to the bushel necessarily the heavier?—in other words, Does it contain more gluten?—Is it the best for the baker, the most nutritive for the consumer? We are prepared to show that it is not.

The subject of specific gravity is rather difficult for parties unaccustomed to these matters to conceive, and it is particularly so in the case of a body consisting of individual grains like wheat.

It is easy to understand and express the relation in weight existing between a cubic foot of water, of marble, and of iron. We should find, if we weighed this quantity of the three substances named, that the marble would weigh nearly three times and the iron seven times as much as the water. But the weight of a given bulk of any substance can only be compared with that of another (for the sake of determining the relative weights of the matter composing them) when there are no interstices or hollows in it. Wood is considered to be lighter than water because it floats upon it, but this is due to the air contained in its pores. Wood is really much heavier than water, and in consequence sawdust will be found very shortly to fall to the bottom of a vessel of water into which it is thrown.

Now this reasoning applies equally to wheat. Were the grains of wheat solid bodies of large dimensions, so that they could readily be measured by the rule, or indeed were the grains all exactly of one size, the relative weight of two specimens could easily be made out, but this is not the case; a bushel of wheat is in the same predicament as a mass of wood; we cannot tell the true weight of the matter composing one or the other by weighing a certain measure of it, because the interstices between the grains of two specimens of wheat may differ in the same way as the pores or hollows of two kinds of wood. The weight, then, of any measure of two different grains will not correspond with their relative weight, supposing them solid, and therefore the weight per bushel may differ, the real weight remaining the same, or *vice versâ*.

This will be better seen if we collect in a table the specific gravities and the weights per bushel of those specimens which we have examined.

TABLE VI.—*Weight per bushel, and specific gravity, of different specimens of Wheat.*

No. of Specimen.	Variety.	Soil.	Specific Gravity.	Weight per bushel.	Ash per cent.
				lbs.	
1	Hopeton . . .	Stonebrash and clay .	1·374	60	1·76
2	Ditto . . .	Stonebrash . . .	1·342	59	1·81
3	April wheat . .	Ditto	1·387	61	1·79
4	Spring wheat .	Calcareous clay . .	1·376	58	1·74
5	Bristol red . .	Brash and clay . . .	1·370	61¾	1·54
6	Clover's red . .	Stonebrash . . .	1·383	61½	1·55
7	Red-chaff Dantzic	Brash and clay . . .	1·387	61	1·36
8	Piper's thickset .	Ditto	1·350	61	1·48
9	White-chaff wheat	Ditto	1·313	59	1·54
10	Hopeton . . .	Ditto	1·354	61	1·51
11	Spalding . .	Stonebrash	1·377	61	1·81
13	Creeping wheat .	Clay and grit . . .	1·375	62	1·55
14	Spring wheat. .	Sand, clay, and grit. .	1·370	62	1·59
15	White wheat .	Clay and grit . . .	1·368	60	1·68
16	Spring wheat .	Calcareous loam . .	1·373	62	1·69
17	Creeping wheat .	Ditto	1·394	62	1·72
18	Ditto . . .	Hazel loam	1·357	61	1·90
19	Ditto . . .	Heavy tough clay . .	1·376	62	1·50
20	Spring wheat. .	Tough clay. . . .	1·363	62	1·60
21	Hammond's wheat	Free clay loam . . .	1·354	60	1·94
22	Red Britannia .	Strong clay . . .	1·369	62	1·82
23	Red wheat . .	Weak clay loam . .	1·352	60	1·75
24	White wheat. .	Weak sandy clay . .	1·351	61	1·59
25	Creeping wheat .	Red clay	1·367	61½	1·70
26	Ditto . . .	Clay and sand . . .	1·365	62	1·73
27	Ditto . . .	Ditto	1·372	62¾	1·65
28	Ditto . . .	Calcareous rubble . .	1·394	63	1·71
29	Red-straw white	Six inches good loam .	1·385	61	1·70
30	Hopeton . .	Three inches loam . .	1·412	60	1·56
31	Ditto . . .	Flint and chalk . .	1·356	56	1·63
32	Piper's thickset .	Good loam	1·339	59	1·73
33	White wheat .	Alluvial	1·382	60	1·60
38	Hopeton . . .	Gritty silicious sand .	1·403	63	1·61
39	Ditto . . .	Stiff clay	1·382	61½	1·63
40	Ditto . . .	Sandy	1·396	62	1·71
41	Ditto . . .	Clay	1·393	60	1·69
42	Ditto . . .	Silicious sand . . .	1·391	62	1·76
43	Red-straw white	Silicious sandy loam .	1·381	62	1·72
44	Ditto . . .	Ditto	1·392	62	1·73
45	Ditto . . .	Calcareous, brashy, and shallow	1·362	61	1·61
46	Ditto . . .	Clay loam	1·413	63	1·60
47	Ditto . . .	Calcareous and silicious sand	1·377	63	1·90
48	Ditto . . .	Calcareous clay . .	1·388	62½	1·73
49	Ditto . . .	Adhesive loam . . .	1·386	61	1·71

In this table we cannot fail to observe a certain degree of connection between the specific gravity and the weight per bushel in many cases. Thus specimens 2, 9, 21, 23, and 31 correspond in having low specific gravities and low weights per bushel, whilst several specimens of high specific gravity give also a good weight per bushel, as specimens 28, 38, and 46. But on the other hand, in the greater number of instances the relation existing between these two circumstances is anything but clear: thus in several samples of the same weight per bushel, the specific gravity is widely different; we need only instance specimens 21 and 30. A glance at the table will supply many other such examples.

The weight per bushel of all the specimens was not experimentally ascertained—although the first 11 from the College farm were in the majority of cases weighed. Specimens 29 to 50 were determined by ourselves. Our method we detail, as it indicates the amount of confidence to be attached to the results obtained.

A very nicely shaped glass flask, with a taper neck, capable of containing about 900 or 1000 grains of wheat, was selected; it was filled repeatedly with the same wheat, various trials being made with the view of ascertaining in what way the nearest approach to the same quantity in each trial could be secured.

It was found that the plan affording most constant results was to allow the wheat to flow gently into the bottle without shaking it. In this way the quantity filling the bottle in several experiments did not ordinarily deviate to the extent of more than five or six grains in each weighing, whilst the difference was usually much less. A discrepancy in weight of 10 grains on 1000 would give a difference of about half a pound on a bushel.

For each of these wheats six or eight weighings were made, and the mean taken as the true contents of the vessel. It is obvious that by this plan we obtain the relative weight per bushel of different samples, and could immediately deduce the absolute weight were we provided with a standard of comparison—a specimen, that is, of known weight per bushel. Such a standard was obtained by comparing three specimens of wheat supplied to us by Mr. Farmer of the Enfield Mills, and of which the weight per bushel had been ascertained. We discovered that whilst two of these specimens agreed, when tested by our method, with the stated weight, the third exhibited a certain deviation which induced us to reject it as incorrect.

By these two specimens we have decided the weight per bushel of all the others mentioned. We believe our method, which was adopted on account of the smallness of the samples, has afforded us results to within a quarter of a pound to the bushel, if not absolutely, at least relatively correct, and this is all we need in determining the relation of specific gravity and weight per bushel; at

the same time we may state that Mr. Morton considers we have given proper weights for his specimens.*

We think then that an inspection of the preceding table will demonstrate the fact, that whilst a great weight per bushel is a certain indication of great absolute weight, and therefore of superior quality, a low weight per bushel does not always prove a sample to be inferior; on the contrary, that a specimen having a high weight per bushel may frequently be inferior in actual weight—contain, that is, less gluten than another of comparatively low weight per bushel. We regret that we cannot speak positively as to the specific gravity or true weight being always the mark of a wheat rich in gluten;—it was and is our intention to set this matter at rest, but we have not been enabled to obtain the necessary results for this Report, and it must consequently be deferred till a future number of the Journal appears: it is quite possible that the quantity of bran may affect the specific gravity of wheat. That the ash is not the cause of this deviation, will be seen by inspecting the columns of the table.

The quantity of water in the different parts of the wheat plant next requires notice. We have before said that a certain amount of water appears to be natural to the grain, straw, and chaff of wheat. If, when damp, they are exposed in a moderately warm and dry atmosphere, they soon lose their superabundant moisture, becoming to all appearance dry, but still retaining a certain and very considerable portion of water. This water is not, however, essential, although natural to them; for either of the three may by a heat under that of boiling water be perfectly dried without apparent injury or alteration of structure.

The water in the grain varies between the limits of 9·5 and 13·5 per cent.: in the greater number of instances it is, however, between 10 and 12 per cent. The mean of all the specimens examined (62 in number) is found to be 11·69 per cent.

In the straw the quantity of water ranges between 10·5 and 14·00 per cent.; the mean on 40 specimens being 11·96.

The chaff, when dried, loses from 11 to 14 per cent. of water; in one case (Spec. 21) it amounted to 16 per cent., the crop having been injured by floods. The mean proportion of water in the chaff of wheat taken on 40 specimens is 12·21 per cent.

It would thus appear that nearly one-eighth part of the whole wheat crop consists of water—about 20 tons of which are therefore removed by it from a farm of 400 acres.

* Mr. Morton's specimens have all, with one exception, a high specific gravity; this, taken into account with the excellent crops, of which the samples form part, indicates the advantage of high and judicious farming both as to quantity and quality of produce.

We now come to consider the mineral matter in the different parts of wheat, and first as to its quantity. The following tables give the amount of variation in the ash of all the specimens before described.

No. of Specimen.	Name of Specimen.	Clay Soils.			Sandy (Silicious) Soils.			Calcareous Soils.		
		Ash of Grain.	Ash of Straw.	Ash of Chaff.	Ash of Grain.	Ash of Straw.	Ash of Chaff.	Ash of Grain.	Ash of Straw.	Ash of Chaff.
1	Hopeton . .	1·76	3·85	9·18	..	..	..	..	..	..
2	Hopeton . .	..	..	..	..	..	..	1·81	3·77	9·31
3	April Wheat . .	..	..	..	..	..	..	1·79	3·73	6·94
4	Spring Wheat .	1·74	4·60	11·56	..	..	..	..	..	..
5	Bristol Red . .	..	..	..	..	..	..	1·54	3·92	11·98
6	Clover's Red . .	..	..	..	..	..	..	1·55	3·20	7·61
7	Red-Chaff Dantzic .	..	..	..	..	..	..	1·36	4·87	12·97
8	Piper's Thickset .	..	..	..	..	..	..	1·48	5·00	8·52
9	White-Chaff Wheat	..	..	..	..	..	..	1·54	4·76	10·27
10	Hopeton . .	..	..	..	..	..	..	1·51	3·77	11·34
11	Spalding . .	..	..	..	..	..	..	1·81	3·57	7·30
13	Creeping . .	..	..	..	..	..	..	1·55	4·33	16·46
14	Talavera . .	..	..	..	..	..	..	1·59	4·00	14·38
15	White Wheat .	..	..	..	..	..	..	1·68	3·36	13·00
16	Talavera . .	..	..	..	..	..	..	1·69	5·08	16·47
17	Creeping Wheat .	..	..	..	..	..	..	1·72	5·50	15·06
18	Creeping Wheat .	..	..	..	..	..	..	1·90	6·83	14·34
19	Creeping . .	1·50	4·08	11·97	..	..	..	..	..	..
20	Talavera . .	1·60	5·98	15·24	..	..	..	..	..	..
21	Hammond's . .	1·94	4·65	13·71	..	..	..	..	..	..
22	Red Britannia .	1·82	5·16	14·48	..	..	..	..	..	..
23	Red Wheat . .	1·75	5·65	13·02	..	..	..	..	..	..
24	White Wheat .	1·59	4·00	13·46	..	..	..	..	..	..
25	Creeping Wheat .	1·70	3·73	13·40	..	..	..	..	..	..
26	. .	..	..	..	..	..	..	..	..	..
27	. .	..	..	..	..	..	..	..	..	..
28	. .	..	..	..	..	..	..	..	..	..
29	Red-Straw White .	1·70	..	..	..	..	..	..	..	..
30	Hopeton . .	1·56	..	..	..	..	..	..	..	..
31	. .	..	..	..	..	..	..	..	..	..
32	Piper's Thickset .	1·73	11·00	15·51	..	..	..	..	..	..
33	. .	..	..	..	..	..	..	..	..	..
38	Hopeton . .	..	..	..	1·61	4·09	12·45	..	..	..
39	Hopeton . .	1·63	4·27	14·29	..	..	..	..	..	..
40	Hopeton . .	..	..	..	1·71	4·07	11·77	..	..	..
41	Hopeton . .	1·69	5·15	12·24	..	..	..	..	..	..
42	Hopeton . .	..	..	..	1·76	4·16	10·36	..	..	..
43	Red-Straw White .	..	..	..	1·72	4·24	10·08	..	..	..
44	Red-Straw White .	..	..	..	1·73	4·68	13·78	..	..	..
45	. .	..	..	..	..	..	..	1·61	2·74	7·04
46	Red-Straw White .	1·60	4·20	9·45	..	..	..	..	..	..
47	. .	..	..	..	..	..	..	1·90	7·36	15·88
48	. .	..	..	..	..	..	..	..	..	..
49	Red-Straw White .	1·71	5·07	11·27	..	..	..	..	..	..

It will be convenient to consider in the first place the quantity of ash in the straw and chaff, in order that the mineral matter of the grain, both as regards its quantity and quality, may come under our notice at one time.

The quantity of ash of wheat straw is usually comprised within the limits of 3·5 and 5 per cent. of its weight. There are, as will be seen by the table, deviations from this proportion—one specimen (No. 45) giving only 2·74 per cent., whilst in Piper's thickset (Spec. 32) the per centage is as high as 11.

There is no very evident connection between the quantity of ash and the soil upon which the specimen has grown; but if we may judge from the mean of the instances in the tables, it would appear that straw from clays contains the most ash—that from calcareous soils containing less, but more than the produce of sandy (silicious) soils.

The variety of wheat would seem to control the proportion of ash of the straw; and the relative strength of different specimens is certainly to some extent dependent upon its amount. Thus in Piper's thickset (Spec. 32), which possesses a straw of unusual strength, the proportion of ash is very great, more than doubling the usual average. This peculiarity is not observable in another specimen of straw of the same wheat (Spec. No. 8); but we have already remarked the singular lowness of ash in this instance as due in some way to the soil.

The mean of 40 specimens of straw given in the table will be found to be 4·50, or about 100 lbs. of ash for every ton of straw. The greatest quantity of ash removed from an acre by the straw of any crop which we have examined is 243 lbs. (Spec. 47); in this case the per centage of ash is very high. The amount of mineral matter removed from the soil by the straw will of course be dependent on the quantity of straw itself, and therefore on the season.

The proportion of ash in the chaff varies between the limits of 7 and 16 per cent.; more frequently, however, being found between 12 and 15 per cent.; as in the case of the straw, the silicious soils give chaff containing the least ash, and clays the most, the calcareous soils being intermediate in this respect. The ash in the chaff, indeed, in many instances corresponds with that of the straw. Thus in specimens 1, 2, 3, 4, 6, 11, we have a very low per centage of ash both in the straw and chaff; and this might be expected, as the chaff is only a prolongation of the straw. The 40 specimens of chaff give a mean ash of 12·25 per cent.; so that one-eighth part of the chaff of wheat is mineral matter.

We have already shown that chaff contains on an average 12·25 per cent. of water. No less than one-fourth, then, of its whole weight consists of matter incapable of affording nourishment to animals; this should be taken into account in estimating the feeding properties of wheat-chaff. Every ton of it being equivalent to 15 cwt. only of solid vegetable food.

According to the calculation just given, a ton of chaff would contain 274 lbs. (about 2½ cwt.) of mineral matter. The largest amount removed from an acre by the chaff in any of the crops described, is seen in Specimens 32 and 33, where it reaches 85 lbs.

Of the ash in the grain:—

By the table (page 660) it will be seen that the quantity of ash for a given weight of grain is not by any means constant, though

confined within more narrow limits than that of the straw and chaff. The extreme points, high and low, are found to be 1·36 (Spec. 7) and 1·97 (Spec. 35); but the greater number of specimens have afforded from 1·5 to 1·7 per cent. of mineral matter.

The analysis of 62 specimens of the grain has afforded us a mean of 1·67 per cent. This quantity of ash appears of very trifling importance, but will be seen, when we speak of its composition, to be by no means so insignificant as it would at first sight appear. Neither is it small when taken on a large amount of crop. A bushel (of 61 lbs.) of grain will upon the average contain exactly 1 lb. of mineral matter. The crop of an acre (28 bushels) will carry off $\frac{1}{4}$ cwt., and therefore from a farm of 400 acres, on our former calculation, no less than one ton and a quarter of mineral matter will be removed by the grain alone.

We naturally ask, what circumstances influence the quantity of ash in the grain of wheat? We have given the lists of soils and varieties in the table, in order to answer this question as far as the data before us will allow.

The influence of variety on the quantity of ash is not very evident, for we have 5 specimens of Hopeton, and 7 of red-straw white wheat, which, with one exception, give nearly the same per centage of ash. "Piper's Thickset" and red Britannia wheat (Specimens 8, 22, 32), although very peculiar in some respects, do not exhibit any marked deviation with regard to the quantity of ash in the grain.

On the other hand, the character of the soil would seem to have but little to do with the matter; in the list of specimens grown on clay, the same differences are observed as in those from silicious or calcareous soils, whilst the mean of the three affords very little deviation.

Again, Mr. Morton's specimens of red-straw white and Hopeton wheat, although grown on different soils, possess very little latitude in the quantity of ash. In Specimens 38 and 39, 40 and 41, we have very strong evidence against the belief that the soil alone affects the quantity of the ash in the grain of wheat.

The two former of these are from the same field, half of which is sand, the other half clay; the two latter, from another field half sand, half clay.

				Per cent. of ash.
Spec.	38.	Hopeton wheat—	silicious sand .	1·61
,,	39.	,,	clay . . .	1·63
,,	40.	,,	sand . . .	1·71
,,	41.	,,	clay . . .	1·69

It is clear that in these instances no alteration in the quantity of mineral matter of the grain is produced by the very opposite description of soil on which the crops were grown.

Again, does climate exercise any influence on the quantity of ash of wheat? So far as the differences of locality afforded by Sir John Johnstone's specimens in Yorkshire, Mr. Huxtable's in Dorsetshire, Mr. Morton's in the Vale of Gloucester, and our own on the Cotswolds, can afford an answer to this question, it is already given. Climate does not exert any marked influence on the quantity of ash in the grain.

We have, however, better instances than these, in the result of the estimation of ash in several specimens of foreign grain:—

Table VII.—*Per centage of Ash in the grain of Foreign Wheats.*

French wheat	1·55	Rostock wheat	1·61
Egyptian wheat	1·97	Spanish wheat	1·65
Odessa wheat	1·50	Dantzic wheat	1·71
Marianople wheat	1·70	Ditto	1·46
Rostock wheat	1·46	Ditto	1·47

Here we observe differences which are as great, though not greater than in specimens from the soils of our own country. Warm climates cannot be said to favour the abstraction (by the grain) of mineral matter from the soil, for in Spanish wheat we have a low per centage of ash; and although the Egyptian grain gives more ash than any other specimen we have examined, the excess is hardly worth notice.

Spec. —.	Egyptian wheat gives	1·97
„ 21.	From Yorkshire	1·94
„ 53.	April wheat from Worcester	1·92
„ 47.	From Mr. Morton	1·90

We cannot then give to the climate credit for creating differences in respect to the quantity of ash in the grain.

If climate create no difference, aspect and locality are equally insufficient to account for the observed discrepancies.

But though the character of the soil (that is, whether it be light or heavy, silicious or calcareous), though the variety of the crop, the climate, aspect, and locality, do not seem materially or uniformly to influence the quantity of ash, there is still another circumstance which may in part affect the question;—this is, the mineral constitution of the soil, irrespective of texture—the quantity and condition of mineral food at the command of the crop; and although we cannot speak positively on the point, there is evidence in favour of the view, which does not exist for any of the others.

In the early part of this Report several specimens of wheat are described as having been grown in the same field on the College farm. In this field, as before mentioned, a singular failure of two consecutive crops of turnips had occurred—the first of them, before the farm came into the hands of this College.

There are several peculiarities about the crops of wheat which followed these poor crops of turnips. We give a table of them to assist our explanation.

TABLE VIII.—*Specimens of Wheat on No.* 5 *and* 6 *fields, College Farm.*

	Specific Gravity.	Ash of Grain.	Ash of Straw.	Ash of Chaff.
SPECIMEN No. 5.—Bristol red . .	1·370	1·54	3·92	11·98
" No. 7.—Red-chaff Dantzic .	1·387	1·36	4·87	12·97
" No. 8.—Piper's thickset .	1·350	1·48	5·00	8·52
" No. 9.—White chaff . .	1·313	1·54	4·74	11·61
" No. 10.—Hopeton . .	1·354	1·51	3·77	11·34

We have already stated that the lowest per centage of ash which we have met with in the grain of wheat, is that of specimen No. 7 above.

The mean of the ash in wheat is, it will be remembered, 1·67 per cent.; so that the whole of these specimens fall short of the average quantity. Piper's thickset, grown by Mr. Bowly, gives 1·73 per cent. of ash; and red Britannia (Spec. 22), which is of the same character, 1·82 per cent., whilst here the per centage is only 1·48.

It will be observed that the specific gravity of all these specimens is also low; No. 9 being peculiar as possessing the very lowest specific gravity of any sample of wheat which we have examined. But at the same time that we consider some connection to exist between the sterile condition of the soil and the quantity of mineral matter in the crop, we cannot but acknowledge our inability to give a satisfactory account of the matter; for the quantity of crop—the fact of bones and guano having been applied, and other circumstances, would seem to require some other explanation of the observed peculiarities. An analysis of the soil might possibly throw light upon the subject; but unfortunately the time at which our conclusions are obtained, does not admit of this being effected for the present Report. The inquiry will however be resumed in the next paper.

A knowledge of the circumstances which influence the quantity of mineral matter in samples of wheat is really of very great importance, whether their quality is influenced thereby or not; for not only, as will shortly be seen, does the grain rob the soil of a large portion of its most valuable ingredients, but a knowledge of this connection might direct us to the principle upon which the different inorganic substances in plants are regulated.

It is curious that the larger the crop in any instance, the smaller in general is the per centage of ash in the grain.

Twenty-eight bushels has been shown to be the mean crop per acre of the specimens we have examined, and 1·67 per cent. the amount of ash.

If we collect, on the one hand, all those specimens which exceed, and, on the other, those which fall short of this per centage, taking the mean of their quantities and of the per centage of ash, we shall obtain the following result:—

The mean of specimens affording less than 1·67 per cent. of ash, is

30 bushels of grain to the acre,
And 1·56 per cent. of ash.

Of those affording more than 1·67 per cent. of ash, the mean is

27 bushels of grain to the acre,
And 1·76 per cent. of ash.

Now

	Bushels.		Ash.		Bushels.		Ash.
As	30	:	1·76	::	27	:	1·58;

very nearly the amount which our results indicate.

The quantity of ash then would appear to be inversely as the crop—that is, the quantity of mineral matter does not increase with the amount of crop, but is less in proportion to the vegetable matter in the large than in the smaller produce. This would seem to lead to the inference that the quantity of mineral matter present in plants is to a certain extent regulated by the abundance of the supply.

But whilst we point this out as a circumstance worthy of consideration, we repeat that neither variety, soil, climate, manure, nor quantity of crop, will satisfactorily account for the deviations which occur in the quantity of ash in the grain of wheat. Before, however, we proceed further in this inquiry, it will be best to consider the composition of the ash.

Of the chemical composition of the ash of wheat grain:—We have before mentioned the substances of which the ashes of plants in general are composed. The following table shows the amount of each of them in 26 specimens of the ash of wheat:—

TABLE IX.—*Composition of the Ash of different Specimens of the Grain of Wheat.*

No. of Specimen.	Variety.	Soil.	Ash per Cent.	Silica.	Phosph. Acid.	Sulph. Acid.	Carb. Acid.	Lime.	Magnesia.	Perox. Iron.	Potash.	Soda.	Chloride of Sodium.
2	Hopeton	Stonebrash	1·81	2·84	47·00	0·24	0·23	3·20	12·71	0·60	33·15	..	..
10	Ditto	Calcareous brash and clay	1·51	1·41	46·18	0·48	..	2·82	13·99	0·00	33·00	2·07	..
11	Spalding	Calcareous	1·81	2·23	48·21	0·11	0·22	2·88	11·06	0·23	29·76	5·26	..
12	Hopeton		1·48	5·91	41·22	1·91	..	4·29	13·57	1·36	27·06	4·08	0·55
26	Creeping Wheat	Clay and sand	1·73	5·32	46·49	0·61	..	1·50	12·35	0·22	31·18	2·42	..
27	Ditto	Ditto	1·65	2·55	45·64	1·55	..	6·76	13·06	0·11	28·89	1·40	..
28	Ditto	Calcareous rubble	1·71	1·34	48·53	..	..	3·72	12·74	1·40	30·94	1·28	..
29	Red-Straw White	Loam (green-sand)	1·70	9·71	40·91	0·08	0·16	1·45	9·53	3·34	31·00	2·54	0·34
30	Hopeton	Loam	1·56	2·28	45·73	0·32	..	2·06	10·94	2·04	32·24	4·06	0·27
31	Hopeton	Flint and chalk	1·63	4·43	45·30	0·59	..	1·83	12·43	1·76	29·92	6·08	0·64
34	French Wheat		1·55	3·05	43·47	0·35	..	3·47	13·94	0·97	32·39	2·32	..
35	Egyptian Wheat		1·97	4·97	41·03	0·18	..	4·34	11·12	1·18	36·60	0·53	..
36	Odessa		1·50	4·48	45·80	..	..	3·17	14·28	0·89	30·30	1·00	..
37	Marianople		1·70	4·00	34·44	0·24	..	2·05	14·09	trace	35·77	9·06	..
38	Hopeton	Silicious sand	1·61	4·23	39·97	0·15	..	1·32	13·26	..	36·43	4·62	..
39	Ditto	Stiff clay	1·63	3·05	47·33	..	..	4·43	9·32	0·35	32·05	3·38	..
40	Ditto	Sandy	1·71	5·63	43·98	0·21	..	1·80	11·69	0·29	34·51	1·87	..
41	Ditto	Clay	1·69	3·69	49·22	0·18	..	2·51	12·38	0·08	30·32	0·07	1·60
42	Ditto	Silicious sand	1·76	3·29	44·44	..	..	8·21	9·67	0·08	32·14	2·14	..
43	Red-Straw White	Silicious sandy loam	1·72	2·14	49·58	0·60	..	3·27	13·75	0·23	29·75	0·64	..
44	Ditto	Ditto	1·73	2·63	47·44	..	..	3·39	14·05	0·67	29·91	1·87	..
45	Ditto	Calcareous (carboniferous)	1·61	2·76	47·38	0·07	..	6·87	11·46	0·07	30·13	1·25	..
46	Ditto	Clay loam	1·60	3·89	46·79	..	..	1·15	13·39	0·91	30·02	3·82	..
47	Ditto	Calcareous and silicious sand and clay	1·90	2·17	46·61	0·44	..	5·05	14·22	0·09	29·17	2·20	..
48	Ditto	Magnesian clay	1·73	2·05	46·99	0·24	..	6·78	12·76	2·32	26·70	2·12	..
50	White Wheat	Chalk	1·84	5·46	40·57	0·32	..	3·21	9·56	2·06	34·26	4·53	..

It will be seen that the first named, silica, constitutes only a very small proportion of the whole ash; it probably exists only in the skin as a mechanical protection to the grain; in quantity it varies between the limits of 1·30 and 6·00 per cent.; in one instance however the ash contains as much as 9·71 per cent. of this substance, Spec. 29. The specimen in which this unusually large quantity of silica occurs, is also remarkable for the very large proportion of oxide of iron present in its ash; it was grown on the "green-sand," and hence in all probability the peculiarity referred to. The green-sand owes its colour to the large quantity of silicate of protoxide of iron existing in it. When decomposed by liming, or water containing carbonic acid, it would furnish an abundant supply of both these substances, which would pass into the plant. The average proportion of silica in the ash of wheat upon the 28 specimens in the table is 3·66 per cent.

Phosphoric acid, the next body in the table, is certainly the most important of all the mineral ingredients of wheat, both on account of the large proportion of it which exists in the ash, and the very small extent to which it is present in soils.

The ash of wheat contains a quantity of this substance, varying between 40 and 50 per cent. of its weight. In one specimen however (No. 37) the phosphoric acid does not exceed 35 per cent.; but this result does not accord with any other we have obtained. The specimen alluded to is from Marianople; it is in peculiarly small and thin grains, almost approaching in appearance those of rye; it is of interest also in containing a large proportion of soda, not in the place of potash, but in addition to the usual amount of the latter alkali. Specimens 41 and 43 exhibit the highest amount of phosphoric acid in any of the ashes. The mean of phosphoric acid in all the specimens is 45·00 per cent. of the ash. A bushel of wheat of 61 lbs., containing 1·67 per cent. of mineral matter, would require $7\frac{3}{10}$ oz., or taking 28 bushels an acre as an average, we should remove from the soil in the grain of every acre of wheat 12 lbs. 3 oz. The largest amount removed in any crop examined is seen in specimen 47, where it reaches 22 lbs. 5 oz. This sample has been before noticed, from the large amount of ash taken off in the straw; it is in all respects an extreme case, the ash of the grain, the straw, and the chaff, being all unusually high. The large amount of crop with these high per centages renders the specimen the most exhausting of all those which have fallen under our notice.

Sulphuric acid is generally present in the ash of wheat, though in small proportion; it does not exceed in any instance 2·00 per cent., and is usually much less than this. The mean quantity of this acid in the ash is 0·34 per cent., and the largest amount removed by an acre of wheat (in this grain) 8 oz.

Carbonic acid is an ingredient of many ashes; but in the grain of wheat it is seldom met with. The presence of carbonic acid in an ash indicates the existence of organic acids combined with lime, &c. in the plant; the grain of wheat, however, would appear in its matured state never to possess any such organic salts, and consequently the column appropriated for this acid in the table is almost void.

Lime is another ingredient in the ash of wheat: in quantity it varies between 1·5 and 8·00 per cent., being more frequently near the former than the latter number. The mean quantity is 3·61. The largest amount removed from an acre is seen in Spec. 42, where it is 3 lbs. 9 oz.

Magnesia is a highly important constituent of plant ashes: in wheat it varies between 9·00 and 14·00 per cent. of the ash—more often however being found to constitute 11 or 12 per cent. of the mineral matter. Our analyses give us as a mean 12·36 per cent.

A bushel of 61 lbs. contains 2 oz., and an acre of 28 bushels will remove 3 lbs. 8 oz. The largest quantity of magnesia removed in any crop examined by us was 6 lbs. 13 oz. (Spec. 47).

Peroxide of iron exists to a small extent in the ash of wheat: its quantity varies between 0·25 and 3·5, the smaller number being nearer the ordinary quantity. It is remarkable that those specimens which contain most iron are from the chalk districts, or analogous soils. The average proportion of peroxide of iron is 0·81, and the largest amount removed from an acre (Spec. 29) 1 lb. 6 oz.

Potash is, next to phosphoric acid, the most considerable and important of all the substances which exist in wheat ash: in quantity it varies between 27 and 37 per cent., having about the same latitude as phosphoric acid. The mean of 26 specimens is 31·37. A bushel of wheat (61 lbs.) will contain 5 oz., and an acre of 28 bushels will carry off 8 lbs. 15 oz. The largest quantity described in the Report as removed from an acre is 14 lbs.

Soda is an alkali scarcely ever entirely absent from wheat, but present only in small quantity. When compared with potash, it varies between 1 and 5 per cent. of the ash. In one instance, that of the Marianople wheat before mentioned, its quantity its comparatively large, reaching 9 per cent.; but we have as yet met with nothing to induce us to adopt the opinion of Liebig, of the substitution of one alkali for another. At all events this does not appear a usual occurrence. We have not certainly examined any specimens grown in soils where the total absence of the other alkali would necessitate a plant to assimilate soda; but were this possible without great injury to the health of the plant, or defect in quality and quantity of the produce, why do we not find it more frequently the case? If it be indifferent to the plant whether the alkali fur-

nished it be potash or soda, why should the quantity of the latter seldom exceed a sixth part of the former? Again, in guano we have always abundance of common salt and other salts of soda, and yet in Spec. 26, where guano was applied, the proportion of soda does not exceed the mean, which is 2·72.

Chlorine in combination with sodium as common salt, will be seen to be present in some two or three specimens of wheat, but only in very minute quantity; and it is singular that in two of the three instances where it occurs, an unusually large proportion of oxide of iron is also present, as if the same circumstances had led to the peculiarity in both cases. Possibly in these instances the wheat was not fully matured, and these bodies would come under the title of "accidental ingredients."

The absence of soda in any quantity, either *as* soda or as common salt, from both the grain and straw, would seem incompatible with the statement to which much attention has lately been drawn, that common salt is a manure for wheat; or rather perhaps we should say, that it is an argument in favour of the theory which supposes the existence of two distinct classes of manures—one serving as food for plants, the other assisting in preparing that food, or in effecting some other desirable object in the amelioration of the soil. In the first of these ways common salt certainly can have no influence on wheat: it cannot serve as food for the wheat crop, because it is not required, and the little soda existing in the ash, if essential, is always abundantly supplied by the soil. Common salt probably owes its efficacy in part to the power which it possesses of absorbing and retaining moisture—a tendency which would ensure a certain though small supply of moisture to the roots in the driest seasons: it is also poisonous to the wire-worm and other depredators on this crop.

We find, then, that in the ash of different specimens of wheat deviations in the proportions of its several ingredients occur, which, although they do not destroy the principle of uniformity of composition upon which the whole interest of the subject depends, yet tend very materially to interfere with its simplicity.

If wheat requires certain mineral matters for its growth, why should it not always take up these bodies in the same proportion and to the same amount? Why should one specimen of wheat give an ash containing 40 and another an ash containing 50 per cent. of phosphoric acid? Why should the potash differ to such an extent in two samples? We should certainly not have anticipated such an amount of latitude in the composition of the ash from the same kind of plants,—or at all events we should have looked for some evident connection between the mineral matter and the variety of the particular sample. The variety would appear, in the case of wheat grain, to be absolutely without influence on the composition of the ash. This will be seen at once by

examining the proportion of phosphoric acid and potash in the 5 specimens of Hopeton wheat in the table in this page, (Specs. 38, 39, 40, 41, 42). On the other hand, the character of the soil does not much affect the composition of the ash—that is to say, the predominance of any particular substance in the soil does not cause it to be present in greater amount in the ash. In specimen 48, for instance, grown on the magnesian limestone, the quantity of magnesia is very little above the average, and by no means so great as in several other specimens. The ash of samples of wheat from the chalk does not contain more lime than when the wheat has been the produce of a clay or a sand. By reference to the table, however, we shall see that the samples grown upon clay give upon the whole more phosphoric acid than those from sands or light calcareous soils; but the connection either in quantity or composition of the ash with the mineral circumstances of the growth of the crop, is not by any means satisfactory or so uniform as might have been expected. In making up our results, we have been strongly impressed with the wish to discover the cause of this want of correspondence, and we believe we have obtained a clue to it.

The grain of wheat is not homogeneous, consisting of two mechanically distinct parts—the skin or bran, and the flour; and these two, again, are not themselves elementary vegetable principles: the flour contains starch and gluten, sugar and gum: the bran, woody fibre and nitrogenized bodies allied to gluten. Now it is quite possible that each one of these bodies has an ash peculiar to itself both in quantity and composition; and accordingly, as they exist to a greater or less extent in the grain, so will its mineral composition differ. As the bran contains more mineral matter than the flour, a thick-skinned wheat will give a greater quantity of ash than one having less bran. And again, if gluten and starch have a different mineral constitution, the flour of two wheats will be influenced in respect to its ash by the relative proportion of gluten and starch which it contains. We have made an examination of one or two specimens, which, although it by no means clears up the difficulty, gives great promise of leading to some general principle in regard to the ashes of plants. The following table shows the connection existing between the vegetable and mineral constituents of 4 specimens of wheat:—

No. of Spec.	Variety.	Soil.	Whole Grain.			Flour.		Gluten.	Ash of Gluten.	Phosph. Acid.	Potash & Soda.	Magnesia.
			Sp. Gr.	Ash.	Water.	Ash.	Water.					
38	Hopeton	Gritty siliceous sand	1·403	1·61	11·50	0·78	14·50	11·40	0·226	39·97	41·55	13·26
39	Ditto	Stiff clay . . .	1·382	1·63	12·00	0·91	13·00	11·52	0·238	47·38	35·43	9·32
40	Ditto	Sandy . .	1·396	1·71	12·00	0·75	15·00	11·32	0·216	43·98	36·38	11·69
41	Ditto	Clay . . .	1·393	1·69	12·00	0·92	12·00	14·00(?)	0·248	49·22	30·39	12·38

It will be seen from this table that whilst the first two specimens give an equal amount of ash on the whole grain, the ash of the flour yielded by them is very different. The ash on the whole grain is not affected to any considerable extent by the soil, whilst that of the flour is evidently connected with it. The flour of the specimens grown upon clay agree very nearly with each other in the quantity of ash, as do also the two grown upon sand—the two former being however very distinct in this respect from the two latter. In estimating the gluten in the flour, we were obliged by circumstances to adopt the mechanical method, which is by no means so satisfactory as that of ascertaining the amount of nitrogen. The gluten was dried by an oil-bath, but in all probability its determination in specimen 41 is in error from imperfect drying. The per centage of ash in the gluten of all four specimens is so similar as to warrant us in believing that the quantity of gluten itself would have been smaller in the last but from the cause just mentioned.* Of the ash of the gluten, 94 per cent. is insoluble matter, which must consist entirely or in great part of phosphates of lime and magnesia.

Again, it will be seen that whilst in the whole grain the phosphoric acid does not appear in any way to correspond with the per centage of ash in the flour, the outline, at least, of such a connection is observable. A small amount of ash in the flour being accompanied by a small per centage of phosphoric acid on the whole grain, this would indicate that the phosphoric acid is contained in largest quantity not in the bran, but in the flour.

We have probably here said enough to show that there is great hope that by following up the clue here afforded—by the separate analysis of the bran, flour, starch, and gluten of several specimens, we shall be enabled to trace the connection existing between the mineral and vegetable composition of plants, and to discover the office performed by the different inorganic compounds in the ash. It is extremely probable, as before said, that the elementary principles—the starch and the gluten—may have a constant and invariable ash, both as to quantity and quality, and that the whole differences observed in the ash of the entire grain are to be attributed to alterations in the proportions of the different vegetable principles which it contains. The point once established, the necessary mineral composition of different plants will become a matter of most simple comprehension, being readily determined by a knowledge of its vegetable composition. Possessed of this information, there would be no necessity for the analysis of any but extreme specimens, the produce of particular culture; but it

* The gluten was separated from 500 grains of flour, and the whole of it burned for the per centage of ash.

evidently appears that, in our present state of ignorance regarding the use of mineral matter in the plants, the analysis of one, or even of several samples of any particular plant, will leave us still much in doubt as to the average or ordinary amount and composition of its inorganic ingredients, and the extent of deviation to which they are liable.

In the case of wheat, it is true we may well believe that for practical purposes the number of analyses performed will do away with all further doubt as to its mineral composition and requirements, but this amount of labour can hardly be expended on all other crops.

There is another most interesting point to which we would call attention very shortly. It is the possibility that the ash of plants may in some way be connected with the quantity of water they contain. It cannot fail to strike any one as remarkable, that the grain, the straw, and the chaff of wheat should contain so uniform a quantity of water. Why, when they dry to this extent, do they not lose any more water? Why do they not become thoroughly dry? Can the soluble salts of wheat in any way be instrumental in retaining this portion of water? This is really quite possible.

In carrying out this supposition, we are immediately stopped by the fact, that whilst the grain, straw, and chaff contain nearly equal amounts of water, they differ most decidedly in the quantity of ash. But this is the very circumstance which lends interest to the speculation; for whilst in the grain the silica which performs the part of an external covering is very small, in straw and chaff it reaches—straw, 63·89; chaff, 81·22 per cent. (Spec. 46).

Now, if we deduct this quantity of silica from the total ash of the straw and chaff, we shall find that the remaining mineral substances connected with the internal vegetable matter are very nearly the same as in the grain.

Thus the ash in the grain of Spec. 46 is 1·60 per cent.; the ash of the straw, 4·20, consisting of 2·68 silica, 1·52 other bodies; the ash of the chaff, 9·45, consisting of 7·68 silica, 1·75 other bodies; so that the great dissimilarity in quantity of the ash of the straw and chaff, when compared with that of the grain, is dependent on the great proportion of silica contained in the former, and to this silica we ascribe an office quite distinct from the rest of the ash. Again, barley and oats, which contain about the same per centage of water, afford much more ash when burned than wheat; but this excess is also due to silica; for in Spec. 63 the whole ash is 2·14 per cent., consisting of ·66 silica, 1·48 other bodies; and in Specimens 65, 67, the produce of 64 and 66, the water increases with the proportion of ash.

We are quite aware that our own results furnish exceptions to

any such principle, and that in other plants, such as the turnip, great difficulties would present themselves in every attempt to connect the quantity of water with that of the ash; but there seems a possibility that the greater part of the ash may exist in a state of solution in the grain and straw of the cereals—that it may act in some way as saline solutions do in general, to prevent or retard the decomposition of the vegetable matter; the ash may also be the means of retaining in the plant that amount of moisture which it needs; for, as is well known, all deliquescent salts will render the substances in which they exist constantly moist, and phosphate of potash, which is a very considerable ingredient of the ash of the cereals, falls very little short of chloride of calcium, in the avidity with which it absorbs moisture from the air. But we forbear further speculation on these points at present, trusting that our subsequent investigations may throw much light upon the subject.

The Ash of Straw and Chaff.—It will be seen that we have only in one instance analyzed the ash of straw and chaff separately (Spec. 46). In the other instances the straw was burnt with the quantity of chaff belonging to it—very perfect and unbroken specimens of average length being selected. It will be manifest that, however desirable a separate analysis in each case might be, the time involved by it will not admit of such a proceeding. The agricultural distribution of the crop is divided into grain, and straw, and chaff, the ash of the former being entirely removed, that of the latter being returned to the soil from the manure heap.

The following table exhibits the analyses of nine specimens of wheat straw, with the proportion of chaff belonging to it.

TABLE X.—*Analysis of the Ash of Wheat Straw, and Chaff.*

No. of Spec.	Variety.	Soil.	Silica.	Phosph. Acid.	Sulph. Acid.	Carb. Acid.	Lime.	Magnesia.	Perox. Iron.	Potash.	Soda.	Chlor. Sodium.	Ash of Chaff.	Ash of Straw.
26	Creeping .	Clay and sand .	73·57	5·51	2·14	..	5·91	1·25	0·07	10·51	1 03	..	15·40	4·22
27	Ditto .	Ditto . .	69·66	6 62	3·95	..	7·46	1·56	0·28	10 31	0·13	..	13·04	4·60
28	Ditto .	Calcareous rubble	69·94	8·54	2·33	..	4·94	1·43	0·06	12·48	0·25	..	16·54	4·30
40	Hopeton .	Sand . . .	69·36	5·24	4·45	..	6·96	1·45	0·73	11·79	..	..	11·77	4·07
42	Ditto .	Siliceous sand .	67·10	7·05	5·59	..	4·44	3·27	1 54	10·03	0·85	..	10·36	4·16
44	Red-Straw White .	Siliceous sandy loam . .	70·50	5·77	3·31	..	3 53	3·29	0·14	12 76	0 68	..	13·78	4 68
45	Ditto	Calcareous brash.	71·39	3·37	2·28	..	7·34	3·53	1·11	9·47	1·39	..	7·0[illegible]	2·74
46	Ditto	Clay loam . .	68·92	3·21	2·21	..	5·63	1·76	0·43	15·56	2·29	..	9·45	4·20
48	Ditto	Calcareous clay, dolomitic .	66·13	8·85	2·23	..	6·82	3·62	0·54	11·76	..	..	9·63	4·95

The variation in the composition of the mixed ash of the several specimens in the table is not very great. Sulphuric acid and lime are present in considerable quantity in the straw, but the

specimen of chaff which we have examined did not contain the former, and the latter only in small quantity. We give here a table of the quantity of the different mineral matters contained in a ton of straw and of chaff; and also, for comparison, a calculation of the average quantity of these substances removed by the grain, straw, and chaff of an acre, calculated as before at 28 bushels of 61 lbs.

	Mineral matters in 100 parts of Straw Ash.	Mineral matters in 100 parts of Chaff Ash.	In a ton of Straw.	In a ton of Chaff.	Removed from an Acre. In 28 bushels of grain, at 61 lbs. (1792 lbs.)	Removed from an Acre. In 2109 lbs. of Straw and Chaff (18 cwt. 91 lbs.).
			lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
Silica . . .	63·89	81·22	60 0	172 3	1 $0\frac{6}{10}$	83 8
Phosphoric Acid	2·75	4·31	2 8	9 2	12 13	7 3
Sulphuric Acid	3·09	..	2 14	..	0 $1\frac{5}{10}$	3 12
Lime . . .	7·42	1·88	7 0	4 0	1 $0\frac{3}{10}$	7 1
Magnesia . .	1·94	1·27	1 13	2 11	3 $8\frac{3}{10}$	2 13
Peroxide of Iron	0·45	0·37	0 6	0 14	0 $3\frac{6}{10}$	0 10
Potash . . .	17·98	9·14	17 0	19 6	8 15	13 15
Soda . . .	2·47	1·79	2 5	3 12	0 $12\frac{3}{10}$	0 13
	99·99	99·98	93·14	212 0	28 $6\frac{6}{10}$	119 11

From this table we may learn that the straw and chaff of a given amount of crop (on the average of this year) remove from the soil together very little more than half the phosphoric acid contained in the grain—at the same time, however, requiring twice as much potash.

The quantity of silica removed in the whole produce is very considerable, $\frac{3}{4}$ cwt. of this substance being required for a very moderate crop. The addition of silicate of potash to the land must be tolerably liberal if it is wished to supply by its means the silica required for the wheat crop. A comparison of columns 3 and 4 will show us that, weight for weight, wheat chaff contains three times as much silica and phosphoric acid as the straw; and although, from the quantity of mineral matter it contains, and the woody nature of its vegetable substance, it may not be so nutritious a food for animals as the straw, the manure into which it is converted must be regarded as much more valuable than that produced from the latter.

On the Ash of Barley and Oats.—Our information on these crops is comparatively very limited. Barley gives, as before mentioned, more ash than wheat; but it is singular that the mineral matter of barley, deducting the silica, very closely resembles that of wheat; thus, in specimen 64 we have 2·28 per cent. of ash, of which ·74

per cent. is silica, leaving 1·51 per cent. of other bodies. In 100 parts of this ash we have by calculation

Phosphoric acid . . .	47·10
Magnesia	11·00
Lime	2·20
Potash	30·80
Soda	6·83

which is very similar to the composition of wheat ash. Weight for weight, then, barley contains quite as much phosphoric acid, magnesia, and alkalies as wheat, in addition to a large proportion of silica.

The silica and the per centage of ash are both higher in oats than in barley. The internal mineral matter, when the silica is deducted, will be found to be as rich in alkalies and phosphoric acid as wheat.

The ash of oats, making this deduction of the silica, will contain in 100 parts—

Phosphoric acid . . .	43·00
Magnesia	17·00
Potash	28·00
Soda	3·00

This circumstance in the mineral history of both barley and oats has a most important bearing on considerations of a practical nature; for were the weight of either of these crops equal to that of a crop of wheat, they would exhaust the land to an equal if not greater extent than the latter. This is not quite the case; but still the relative amount of mineral matter removed in the three cereals is by no means so different as is generally supposed. We have endeavoured to draw out something like an average of the three crops and their mineral matter. Let us suppose that we have land of such character as to produce an average crop of either—that is, for an acre,

45 bushels of oats at 42 lbs. = 1890 lbs.; and at 2·60 per cent. ash = 49 lbs. mineral matter.

40 bushels of barley at 48 lbs. = 1920 lbs.; and at 2·20 per cent. ash = 42 lbs. mineral matter.

30 bushels of wheat at 61 lbs. = 1830 lbs.; and at 1·67 per cent. ash = 30 lbs. mineral matter.

The mineral matter of these crops, omitting substances of little importance, would consist of in lbs.

	Phosphoric Acid.	Magnesia.	Potash and Soda.	Silica.
Wheat . .	13·5	3·6	10·2	1·5
Barley . .	13·4	3·0	10·5	12·5
Oats . .	10·6	4·3	7·5	25·0

Here it will be seen that oats (as regards mineral matters) are, upon the supposition of the above being averages, rather less

exhausting than wheat or barley; barley and oats, however, require a much larger amount of silica than wheat; of course we speak of the grain only, not having yet had opportunity to make analyses of the straw of these crops. The exhausting character of a crop should be viewed in two lights. In the case of wheat, for instance, the immediate exhaustion is due to the ash removed in the whole crop, and to which, of course, the straw and chaff contribute very largely; but in the ordinary routine of farm practice this loss is made up by the manure applied, which (if no unusual waste occurs) will represent the inorganic matter of the straw and chaff; there is, however, in addition to this, a permanent loss to the soil in the removal of the grain; and it is of this that we speak in comparing barley and oats with wheat. At the same time we must remark, that from some analyses made by one of us, and detailed in Dr. Daubeny's paper on the rotation of crops, it would not appear that the straw of barley is less exhausting otherwise than in consequence of its quantity being less than that of wheat straw.

The analyses of barley and oats here given we do not consider by any means sufficient to warrant us in drawing any very decided conclusions respecting the mineral history of these crops; we shall therefore reserve any further remarks upon them till a future time.

The ash of rye resembles that of wheat in most respects: if we may judge, however, from the single analysis detailed (Spec. 75), it contains a larger amount of silica. The quantity of ash is low when compared with wheat, and the crop would consequently be less exhausting, as regards the grain, than any other of the cereals.

Of the Method of supplying to the Land the Mineral Ingredients of the Wheat Crop.

We may fairly conclude that, in round numbers, an average crop of wheat would remove from the soil in the grain, straw, and chaff per acre,

84 lbs. of silica.
20 lbs. of phosphoric acid.
4 lbs. of sulphuric acid.
8 lbs. of lime.
6 lbs. of magnesia.
1 lb. peroxide of iron.
23 lbs. of potash.
1½ lb. of soda.

Of these substances three may be considered as non-essentials: these are, the lime, the peroxide of iron, and the soda, all of which, if the plant requires them, it may readily obtain from almost any

soil. To supply the other ingredients in the form of manure of mineral composition alone, we must employ an alkaline silicate—phosphate of lime and a salt of magnesia. The silicates of potash and of soda, as they are manufactured for agricultural purposes, are compounds of very varying constitution. Of silicate of potash, the average amount required for the supply of 84 lbs. of silica would probably be about 2 or $2\frac{1}{2}$ cwts. It is plain that the quantity of potash required by the crop is small when compared with that which would be added in the requisite dose of silicate of potash. We would therefore recommend silicate of soda as a more economical method of supplying this mineral ingredient of plants. The potash must then be applied in another form.

The total phosphoric acid of the wheat crop would be furnished in $\frac{3}{4}$ cwt. or 1 cwt. of unburnt bones; the magnesia by 40 lbs. of sulphate of magnesia (Epsom salts); and the potash by about 35 lbs. of carbonate (pearlash), or 50 lbs. of nitrate (saltpetre); but this last addition will be unnecessary if silicate of potash be employed: the necessary top-dressings will then be—

$2\frac{1}{2}$ cwt. silicate of potash,
1 cwt. of crushed bones,
40 lbs. sulphate of magnesia.

Taking into consideration, however, the very gradual solution of the phosphate of lime of bones, it would no doubt be better to adopt another form of top-dressing for wheat. The following would perhaps be a better application:—

2 cwt. of silicate of soda,
1 cwt. of bones dissolved in
$\frac{1}{2}$ cwt. of oil of vitriol,
40 lbs. of sulphate of magnesia, and
35 lbs. of carbonate of potash.

The bones should be dissolved in the acid previously diluted with an equal measure of water: when they become thoroughly broken down, the sulphate of magnesia and carbonate of potash should be added, and the whole well stirred and left at rest for twenty-four hours. At the end of this time the mixture would in all probability be found sufficiently dry, when broken up, to be distributed by the hand: it might otherwise be mixed with ashes or mould, in order to attain the proper condition.

We have already remarked, that of the total silica required by the wheat, three-fourths belong to the straw, the remainder being found in the chaff and grain. On the other hand, by far the largest proportion of phosphoric acid is appropriated by the grain. Reasoning upon these facts, we should endeavour, as far as possible, to supply the several ingredients at the time when they are wanted.

Two-thirds of the silicate of soda and one-third of the prepared top-dressing might be applied to the young plant very early in the spring; the remainder of both should be reserved and applied as late as practicable, in order that they may be at the command of the plant as the ear fills and the straw and chaff strengthen.

In many soils, such as stiff clays, and in all localities where the soil is formed from granitic or other primary rocks, the addition of silicates will be an unnecessary outlay of money; but the other mixture is comparatively inexpensive, and would always more than remunerate the farmer, if not in the wheat, at least at some other period of the rotation. The advantage of the method of application here proposed mainly consists in the use of soluble phosphates, such as those of potash and magnesia, which are produced when the materials before mentioned are mixed together; for this purpose, however, the employment of sulphuric acid to dissolve the bones is indispensable. It is quite probable that such a top-dressing, from its solubility and tendency to absorb moisture, would take effect when the season is too dry to allow of other applications being made with advantage. But the same solubility will cause its earlier removal from the land by rains and drainage, unless the precaution be taken of applying it at intervals, as we have suggested.

XLI.—*Potatoe Disease in Poland.*

Foreign Office, November 26th, 1846.

Sir,—I am directed by Viscount Palmerston to transmit to you, for the information of the Agricultural Society, an extract of a despatch from her Majesty's consul in Poland, relative to the potato disease.

I am, &c.

E. J. Stanley.

The Secretary to the Agricultural Society.

Extract from Colonel Du Plat's Consular, No. 28, *of Oct.*, 16, 1846.

I stated that the potato disease was totally unknown in this country.

Since making that statement, I have heard of one exception to the rule, which has occurred on a small estate not far from Warsaw, farmed by a Mr. Kedzlie, a British subject of much intelligence, long established in Poland. The potatoes which have

furnished this exception are of the kind called the "*Ash-leaved English Kidney Potato,*" and were obtained from England two years ago; they were planted in the midst of Mr. Kedzlie's other potato crops, on land of the same quality, and prepared exactly in the same way as the rest of the ground, which has yielded perfectly sound fruit.

This circumstance would seem to prove that the disease is not attributable to atmospheric influence, as, I hear, is the generally received opinion of other countries. Here in Poland, all persons to whom I have spoken on the subject think that the potatoes in the rest of Europe are tainted in the germ by over cultivation; and it is certainly remarkable that here, where the soil is generally light, and where less manure is used than in any other country, except Russia—and never immediately preceding the crops of potatoes—those plants should have completely escaped the infection which threatens their extinction in all parts where greater pains have been taken with their culture.

I do not imagine that the opinion alluded to, or the isolated fact which I have mentioned, will decide a question which has so hopelessly occupied the attention of first-rate scientific men in many countries, but I hope that the notice of the circumstances will not be deemed irrelevant at a time when the disease in question is the cause of such dire distress in her Majesty's dominions, as well as in other parts of Europe

XLII.—*Arboriculture.*

To the Secretary.

Sir,—I do not know whether the Agricultural Society considers Arboriculture as within its province; at all events, I will state to you some observations which I have made in a plantation which I am now thinning, and leave it to you to decide whether they are likely to be of any interest to the Council.

The plantation in question was made at three different periods: the first part about the year 1807; the second part about 1812; the last about 1819. As the first was intended as a screen or belt, it was of little width, and planted in trenched ground; the two latter were intended for coverts for game, and holes were made for the trees in the grass. The land is of very good quality—a loam upon clay. I find all the larch, without a single exception, in the trenched ground—that is, in the part first planted—decayed, whereas I never saw finer or better larch than those in the other plantation. I send you a valuation made by my woodman of seven trees in the first and second parts, by which you will

see the difference of growth of the larch in each. Whether this decay has arisen from the too rapid growth of the trees in the first instance, owing to the land having been trenched, or to any peculiarity in the atmosphere at the time the first plantation was made, is a very important question, as that decay has been found in plantations in every part of the kingdom, and in every variety of soil; and the nurserymen are actually importing their seed from the Tyrol, concluding that the mischief arose from a deterioration of the plant itself in our climate. I may add that I have larch here supposed to be above eighty years old:

In the Trenched Ground.

Length in feet.		Quarter girt.		Ft.	In.	Pts.		
31	by	5	..	5	4	7		
29	,,	$5\frac{3}{4}$	..	6	7	10		
30	,,	4	..	3	4	0		
34	,,	$5\frac{3}{4}$	..	7	9	8		
34	,,	$6\frac{1}{2}$	..	9	11	8		
34	,,	$5\frac{1}{4}$	..	6	6	1		
33	,,	$5\frac{1}{4}$	..	6	3	9		
				45	11	7	at 1*s*. ...	2*l*. 5*s*. $11\frac{1}{2}$*d*.

In the Ground not Trenched.

Length in feet.		Quarter girt.		Ft.	In.	Pts.		
35	by	$6\frac{3}{4}$	..	11	0	10		
35	,,	$5\frac{1}{2}$	..	7	4	2		
39	,,	$6\frac{1}{4}$	..	10	6	11		
34	,,	$6\frac{1}{4}$	..	9	2	8		
36	,,	$6\frac{1}{4}$	..	9	9	2		
32	,,	5	..	5	6	8		
32	,,	$5\frac{1}{2}$	..	6	8	8		
				60	3	1	at 1*s*. 2*d*. ..	3*l*. 10*s*. 3*d*.

I am, Sir, your obedient servant,

J. Spencer Stanhope.

Cannon Hall, November 16.

XLIII.—*Report on the Exhibition of Implements at the Newcastle-upon-Tyne Meeting*, 1846. By JOSIAH PARKES, Consulting Engineer to the Society.

THE show at Newcastle-upon-Tyne constituted the eighth anniversary of the Society's country meetings; and although it is true that so large a number of implements was not exhibited as on one or two former occasions, yet applications were made for seventeen more stands than at Shrewsbury, and more exhibitors appeared. The show-yard did not perhaps contain so many implements as at Shrewsbury; but this was, doubtless, attributable in part to the great distance of the exhibition from those districts of England where the implement-makers chiefly reside, and was partly owing to the repeated expression of the judges' opinion that exhibitors would act more wisely in restricting the number of their specimens to a fair measure of variety in respect of manufacture and cost, rather than in augmenting their expenses, and encumbering the show-yard with repetitions of identical articles. A marked improvement was visible in the adaptation of several important implements to their uses, as will appear from the observations of the judges.

Prizes offered by the Society.

For the Plough best adapted to heavy land . .	Ten Sovereigns.
For the Plough best adapted to light land . .	Ten Sovereigns.
For the best Skim or Paring Plough	Five Sovereigns.
For the best Subsoil Pulverizer	Ten Sovereigns.
For the best Scarifier	Ten Sovereigns.
For the best Harrow	Five Sovereigns.
For the best Drill for general purposes, which shall possess the most approved method of distributing Compost or other Manures in a moist or dry state, quantity being especially considered	Fifteen Sovereigns.

N.B.—Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.

For the best Turnip Drill on the flat, which shall possess the most approved method of Distributing Compost or other manures in a moist or dry state, quantity being especially considered	Ten Sovereigns.

N.B.—Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.

For the best Turnip Drill on the ridge, which shall possess the most approved method of distributing Compost or other Manures in a moist or dry state, quantity being especially considered	Ten Sovereigns.

N.B.—Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.

For the best Drill Presser depositing Manure and Seed	Ten Sovereigns.
For the best Horse-Seed-Dibbler	Fifteen Sovereigns.
For the best Hand-Seed-Dibbler	Five Sovereigns.
For the best Chaff-Cutter	Ten Sovereigns.
For the best Linseed-Crusher	Five Sovereigns.
For the best Steaming Apparatus for Roots . .	Five Sovereigns.
For the best Weighing Machine for Live Cattle and Farm Produce generally	Ten Sovereigns.
For the best Churn	Five Sovereigns.
For the best One-Horse Cart	Five Sovereigns.
For the best Threshing-Machine	Twenty-five Sovereigns.
For the best Steam Power, applicable to Threshing, or other Agricultural purposes . . .	Twenty-five Sovereigns.
For the best Horse Power, applicable to Threshing, or other Agricultural purposes . . .	Twenty-five Sovereigns.
For the best Machine for making Draining Tiles or Pipes for Agricultural Purposes. Specimens of the Tiles or Pipes to be shown in the Yard: the price at which they have been sold to be taken into consideration, and proof of the working of the Machine to be given to the satisfaction of the Judges	Twenty Sovereigns.
For the best and most economical Set of Tools and Instruments for Draining purposes . .	Ten Sovereigns.
Miscellaneous Awards, at the discretion of the Judges	Forty Sovereigns.

For the Invention of any New Implement, such sum as the Council may think proper to award.

AWARDS.

Implements and Exhibitors' Names.	Society's Prize.	Reference to Catalogue. Stand.	Article.	Price. £ s. d.
1. Ploughs.				
To John Howard, of Bedford, for his Iron Plough with two wheels for heavy land; invented and manufactured by J. Howard and Co., of Bedford	£10	73	4	5 0 0 to 5 6 0
To John Howard, of Bedford, for his Iron Plough with two wheels, for light land; invented and manufactured by J. Howard and Co., of Bedford	£10	73	4	5 0 0 to 5 6 0
2. Subsoil Pulverizers.				
To John Read, of 35, Regent's Circus, Piccadilly, London, for his Subsoil Pulverizer; invented and manufactured by himself .	£10	73	1	5 5 0
3. Scarifiers.				
To William Crosskill, of Beverley, Yorkshire, for his Scarifier, or Uley Cultivator; invented by John Morton, of Whitfield, and manufactured by W. Crosskill	£10	18	64	10 0 0 to 12 12 0
4. Harrows.				
To Richard Coleman, of Colchester, Essex, for his Expanding Lever Harrow; invented and manufactured by himself . . .	£5	5	1	8 0 0 to 9 0 0
5. Drills.				
To Richard Hornsby, of Spittlegate, Grantham, Lincolnshire, for his Drill for general purposes and distributing compost; invented and manufactured by himself . . .	£15	61	6	52 0 0
To Thomas Hunter, of Ulceby, near Barrow-on-Humber, Lincolnshire, for his Five-row Turnip Drill on the flat, and for distributing compost; invented and manufactured by himself	£10	59	2	26 10 0
To John Teasdale, of Burneston, near Bedale, Yorkshire, for his Two-row Turnip Drill on the ridge, and for distributing compost; invented and manufactured by himself . .	£10	93	1	11 11 0
6. Drill Pressers.				
To Richard Hornsby, of Spittlegate, Grantham, Lincolnshire, for his Two-row Drill Presser, depositing seed and manure . . .	£10	61	8	15 10 0

Implements and Exhibitors' Names.	Society's Prize.	Reference to Catalogue. Stand.	Article.	Price.
				£ s. d.
7. HAND-SEED DIBBLERS.				
To Dalrymple Crawfurd, of Moseley Road, Birmingham, for his Hand-Seed Dibble; invented and manufactured by himself . .	£5	15	1	1 5 0
8. CHAFF-CUTTERS.				
To John Cornes, of Barbridge, Nantwich, Cheshire, for his Chaff-cutting Machine with three knives; invented and manufactured by himself	£10	49	1	12 12 0 to 6 0 0
9. LINSEED CRUSHERS.				
To William Crosskill, of Beverley, Yorkshire, for his Hand Power Mill for crushing linseed; invented and manufactured by Messrs. Ransomes and May, of Ipswich . . .	£5	18	76	5 5 0
10. STEAMING APPARATUS.				
To Richard Robinson, of Lisburn, county Antrim, Ireland, for his portable Steaming Apparatus for roots; invented by J. Jennings of New York, and manufactured by the exhibitor	£5	31	9	7 10 0
11. WEIGHING MACHINES.				
To Messrs. James and Co., of 44, Fish Street Hill, London, for their portable Machine for weighing live stock, farm produce, &c.; invented by William Clarke, of London, and manufactured by themselves . . .	£10	74	2	24 0 0 and various.
12. CHURNS.				
To Richard Robinson, of Lisburn, county of Antrim, Ireland, for his Churn, improved and manufactured by himself . . .	£5	31	4	3 0 0
13. ONE-HORSE CARTS.				
To William Crosskill, of Beverley, Yorkshire, for his One-horse Cart for general purposes .	£5	18	14	10 0 0 to 15 15 0
14. THRESHING MACHINES.				
To Messrs. Richard Garrett and Son, of Leiston Works, Saxmundham, Suffolk, for their bolting Threshing Machine, manufactured by themselves	£25	28	17	27 10 0
15. DRAIN-TILE OR PIPE MACHINES.				
To Thomas Scragg, of Calveley, near Tarporley, Cheshire, for his Tile and Pipe Machine; invented by himself, and manufactured by James Hewitt, of Calveley . . .	£20	13	1	28 0 0 to 35 0 0

Implements and Exhibitors' Names.	Judges' Awards.	Reference to Catalogue. Stand.	Article.	Price.
MISCELLANEOUS.				
To Messrs. Richard Garrett and Son, of Leiston Works, Saxmundham, Suffolk, for their Tile and Pipe Machine; invented by Richard Weller, of Capel, near Dorking, Surrey, and manufactured by themselves . . .	£5	28	39	25 0 0
To Messrs. Richard Garrett and Son, of Leiston Works, Saxmundham, Suffolk, for their Kent Drill, improved and manufactured by themselves	Silver Medal.	28	6	26 0 0 to 30 0 0
To Richard Stratton, of Bristol, for his Norwegian harrow; improved and manufactured by himself	£5	94	32	13 10 6 to 19 10 6
To Messrs. Barrett and Ashton, of Hull, Yorkshire, for a Spiked Roller or Clod-Crusher; invented by John Naylor, and manufactured by themselves	Silver Medal.	4	1	24 0 0
To Messrs. H. Smith and Co., of Stamford, Lincolnshire, for their Land Cultivator; invented by S. Smith, of Northampton, and manufactured by themselves . . .	Silver Medal.	42	11	15 0 0
To Richard Hornsby, of Spittlegate, Grantham, for his Winnowing Machine, invented and manufactured by himself . . .	£3	61	7	13 0 0
To Zachariah Parkes, of Birmingham, for his Portable Steel Mill; invented and manufactured by himself	£3	97	3	7 0 0
To Messrs. H. Smith and Co., of Stamford, for their double-acting Haymaking Machine; improved and manufactured by themselves	£5	42	9	14 0 0
To Joseph Cook Grant, of Stamford, for his Horse Hay-Rake; invented and manufactured by himself	£3	56	1	7 10 0
To Edward Pierce, of Llanasa, near Holywell, Flintshire, for his machine for spinning Hay Ropes; invented and manufactured by himself	£2	29	1	5 0 0
To William Croskill, of Beverley, Hull, for his Wheels and Axle; invented and manufactured by himself	Silver Medal.	18	19	4 0 0 to 10 15 0 per pair.
To Richard Robinson, of Lisburn, county Antrim, Ireland, for his Cart Axle; invented and manufactured by John Rowan and Sons, of Belfast	£5	31	13	7 10 0
To James Richmond, of Salford, Manchester, for his Root-Washer; manufactured by himself	Silver Medal.	81	12	4 4 0
To E. W. Harding, of Oldsprings, near Market Drayton, Salop, for his Whippletrees; invented and manufactured by himself . .	Silver Medal.	9	1	0 5 6

Implements and Exhibitors' Names.	AWARDED BY THE COUNCIL.	Reference to Catalogue.		
		Stand.	Article.	Price.
				£. s. d.
To William Crosskill, of Beverley, Hull, for his Clod-Crusher; invented and manufactured by himself	Gold Medal.	18	1 to 10	12 0 0 to 27 10 0

NOTE.—The prices affixed comprehend the range of the cost according to the various sizes, materials, fittings, &c., of the implements.

Ploughs.—The only fault to be found with the ground destined for the trials of the field implements was that the heavy land did not prove to be so stiff as is desirable on these occasions. In other respects the choice was perfectly satisfactory both to the judges and exhibitors, and the condition of the soil for the various trials could not have been more suitable at any period of the year.

The trial-ground was conveniently situated about two miles from Newcastle, at the farm of Mr. Henry Hall, of Gosforth Cottage, with whose preparations and attentions the stewards and judges had every reason to be well satisfied.

Ploughing was first commenced on the light land, seventeen implements having been selected for competition, some of which were furnished with two wheels, some with one wheel, and some worked without a wheel, or as swings; each plough being set to complete a land, without the interference of any party on the spot, until the whole performance was complete.

The manifestation of superiority in favour of the two-wheel ploughs made by Messrs. Howard and Co., of Bedford, was unquestionable, and in all the respects which would guide the judgment of a competent farmer in his choice of this important implement. They had two ploughs in the field, bearing the marks J. A. and H. L. It was the latter plough to which the judges awarded the prize of 10*l.*, remarking "that the sole of the furrow was cut perfectly flat, the land side clean and true, the furrow-slices were laid with perfect uniformity throughout the field, and in a beautiful position for receiving the seed." The J. A. plough was considered to be next in merit to the H. L., and but in a trifling degree inferior to the latter.

Good work was done by several other ploughs in the field—the judges commending those respectively made by Mr. Grant, of Stamford; Mr. David Harkes, of Mere, Knutsford, Cheshire; and Messrs. Barrett and Ashton, of Hull; but observing that these parties "have much lee way to fetch up before their implements can equal the work done by Messrs. Howard's plough."

Fourteen ploughs operated upon the heavy land, and nearly similar distinctive characteristics were appreciated in the results; the judges again awarding the Society's prize of 10*l.* to Messrs. Howard's H. L. plough, the work of the J. A. being next in quality—commending the performance of a two-wheel plough by Mr. Roberts, of Warwick, which, however, was thought to break its furrows too much, and to be better adapted for fallowing than seeding—with approbation of the work done by the ploughs of Mr. Harkes, and of Messrs. Barrett and Ashton. The judges did not consider the excellence of Messrs. Howard's work on this heavier land to be quite so transcendent as on the lighter soil; and conceived that the makers would have done well to change their mouldboard for the deeper furrow ploughed in this case, rather than have retained, as they did, the same mouldboard which was used on the light land. They, nevertheless, gave it as their opinion that no plough exhibited on this occasion possessed the power or construction to move soil to equal depth, and with the same precision, as Messrs. Howard's implements.

Skim or Paring Plough.—The offered prize for this implement was withheld, as the work was not considered to have been so satisfactorily performed as to justify the rewarding any of the implements tried, which fell short of the excellence attained on former occasions.

Subsoil Pulverizers.—The subsoil of the field on which these trials took place required draining, and was too wet for a perfect proof of the capabilities of implements which ought only to be used on stiff land after being well drained and when in a dry state. The judges again awarded the prize to Mr. John Read, of Regent Circus, Piccadilly, London. The stirrer used on this occasion was not thought to be so effective as it might be made, but the subsoil was unquestionably in an unfit state for this purpose. Mr. Read has, however, since benefited by the suggestions of the judges, and contrived stirrers to suit all states of soil.

The implement made by Messrs. R. Gray and Sons, of Uddington, near Glasgow, received much commendation. Messrs. Barrett and Ashton, of Hull, also produced a pulverizer of considerable merit.

Scarifiers and Cultivators.—The show-yard contained a large variety of these implements, many of which were put to trial, as grubbers in the first instance, in a rough fallow, then as scarifiers on a clover ley. The prize was awarded to the well-known Uley cultivator, as it was found to pare the surface very much better than any of its competitors, and it made good work in moving the soil. Still the judges expressed a very decided opinion in favour of the implement for the first time exhibited by Messrs. H. Smith and Co., of Stamford, having nine tines, clearing five feet

in breadth, and being cleverly worked by four horses. It is entirely composed of wrought iron, with an excellent lever apparatus for adjusting depth and raising the tines out of the ground. This implement worked in a very lively manner, and was thought to offer less drag to the team than any of the others; but it fell short of the Uley in surface-skimming.

A scarifier by Messrs. Barrett and Ashton, of Hull, was also commended by the judges, who, however, conclude their observations on this class of implements by remarking that they consider them yet open to great objections, and that they need considerable improvement.

The silver medal was awarded to Messrs. H. Smith and Co. for their implement.

Harrows.—The judges report most favourably of a new expanding harrow invented by Mr. Richard Coleman, of Colchester. This implement is mounted on four light wheels, adjustable by levers to govern the depth of penetration by the teeth into the soil, so that it becomes a light or heavy harrow at will. It is readily expanded to cover 12 feet, or contracted to the compass of 4 feet. It worked admirably on very rough land; and the Society's prize of 5*l.* was conferred on Mr. Coleman for this meritorious invention.

The Norwegian harrow, which created so much interest at the Shrewsbury meeting, and a description of which will be found in that Report, was again produced by Mr. Stratton, of Bristol, with several improvements in its construction and means of management. The judges considered the specimen covering 5 feet in breadth to be the best adapted for all descriptions of soil; and observed that it is capable of thoroughly breaking up the furrow slices from 3 to 6 inches deep, as the farmer may require, leaving the soil in a beautifully pulverized condition. An award of 5*l.* was given to Mr. Stratton for this implement; and a silver medal to Messrs. Barrett and Ashton, of Hull, for a spiked roller or harrow—a powerful tool, which was thought well adapted for reducing very hard cloddy land, but not calculated to leave it in such fine tilth as the Norwegian.

Drills.—The competition for the three prizes offered by the Society was ably sustained by the several well-known skilful manufacturers of these machines. Mr. Hornsby, of Grantham, obtained the prize for the drill for general purposes; Mr. Hunter, of Ulceby, Lincolnshire, that for turnips on the flat; and Mr. Teasdale, of Burneston, near Bedale, Yorkshire, that for turnips on the ridge.

The remark by the judges that these invaluable implements may now be considered to rank among the most perfect in the list of agricultural machinery will be appreciated by the members

of the Society, and the more so by those who know the judges to have been all drill-farmers, critical, and chary of praise.

Mr. Hornsby introduced a very important, though very simple, improvement in the arrangement and weighting of the coulter-levers, and his mode of fixing the levers was considered preferable to that of any other maker. In action, the seed and manure were very accurately deposited and covered.

The prize given to Mr. Hunter for flat turnip-sowing was determined by the fact of his drill only—three others competing with it—being able to deposit and well cover the coarse manure provided by the Society; and the writer is enjoined by the judges to state their opinion that on future occasions the manure for these trials should be prepared by some accustomed drillman, so that its condition may be unexceptionable for the severest trials.

The tilth of the soil for the ridge-work trial is reported by the judges to have been beautiful, and all that could be desired. Drills by Messrs. Hornsby, Garrett, Smyth, and Teasdale competed. Mr. Teasdale carried off the prize, distancing his opponents in the appetite of his machine for manure, and in its power of passing and depositing it accurately. The experiment was made on very extreme and unnecessary quantities, but the judges observe on this faculty, as their predecessors have frequently done that in practice that drill proves at all times equal to deposit the less quantity more certainly, which will deposit the greatest quantity and cover it neatly on a particular trial.

The form of the cone of Mr. Teasdale's rollers proved admirable for the purpose, the ridge being scarcely flattened by them and the coulters were as well adapted to maintain deposition direct on the ridges, which preserved their true shape, although large quantities of manure and seed were sown and well covered with earth.

The judges observe that all the drill exhibitors on this occasion merit the approbation of the Society for their efforts and success in improving these machines.

A machine, termed by Mr. Garrett the "improved Kent drill,' was exhibited and tried to the complete satisfaction of the judges It is particularly well adapted for use by small farmers, embracing about 5 feet of ground at once, depositing and covering both manure and seed perfectly. The Silver Medal was worthily bestowed for this implement.

Drill Pressers.—Mr. Hornsby was the only exhibitor of this article, but, although no competition was offered, the judges did not hesitate to award the Society's prize of 10*l.* for it, by reason of its superior construction and capital working qualities, being well adapted for all those soils which occupiers may consider better suited to the operation of the presser than the drill.

Horse Seed-Dibblers.—Two machines of this kind were exhibited, the one, well known, by Mr. Newberry, of Hook Norton, Oxon; the other, a new one, by Messrs. Barrett, Exall, and Andrews, of Reading. The judges were of opinion that Mr. Newberry's machine had undergone considerable mechanical improvements, and that he had enlarged its scope without requiring greater power of draught; but, on trial, the deposition failed, and for the accidental reason of new paint adhering to the delivering parts, as stated by Mr. Newberry, which the judges fully believed.

The judges augur well of the implement produced by Messrs. Barrett and Co., and trust that these makers will again exhibit it; but, from some derangement which had occurred in its transit to the show-yard, this machine also would not act. Thus the Society's prize for this object could not be awarded.

Hand Seed-Dibblers.—Several machines were exhibited for abridging labour of this kind, and for regulating with more precision than hand-dropping has yet done the number of seeds deposited. The prize was given to Mr. Crawford, of Birmingham, and principally because of his implement dropping in one hole a fewer number (yet enough) of seeds than others.

The other competing implements were hand dibblers produced by Mr. Hodgkins, of Birmingham, and a hand-barrow machine by Mr. Newberry, with a single depositing wheel. The number of corns deposited in 11 successive holes by each was as follows:—

Crawford	2	1	2	1	3	2	3	3	1	4	5
Hodgkins, single . .	5	4	4	2	3	5	4	4	3	4	3
——— double . .	3	2	1	2	3	3	3	3	2	2	2
Newberry	6	7	7	7	7	8	8	8	10	9	5

The judges commend Mr. Newberry's wheel machine, but consider the quantity of grains put into each hole as unnecessary and unreasonable.

Hay-Making Machines.—Two machines only were exhibited, and both were fully tried on a good crop of grass, first spreading it from the swathe, and afterwards reversing the action, *i. e.* turning the same grass back. Both machines acted remarkably well in doing this plain work on even ground; but Messrs. Smith's machine having a handy leverage for enabling the managing man to depress or raise the spikes quickly—a matter of great practical convenience—an award of 5*l.* was given by the judges to these makers, rather than to their competitor, Mr. Grant, both of Stamford.

Hay-Rake.—Mr. Grant, of Stamford, again obtained from the judges an award of 3*l.* for his excellent horse-rake, which was found to be much improved.

Hay-Rope Machine.—A very simple and effective machine for twisting hay-bands was produced by a poor working Welshman, Edward Pierce, of Llanassa, near Holywell, which did its work scientifically well, and was rewarded by a judges' premium of 2*l*. Price 5*l*.

Whipple Trees.—The silver medal was accorded to Mr. Harding, of Oldsprings, near Market Drayton, for his admirably simple, cheap, and strong dragging bars. These are articles which every farmer should possess.

Weighing Machines,—The Society's prize of 10*l*. was adjudged again to Mr. James, of 44, Fish Street Hill, London. It is possible that the amount of portability which could be desired may be unattainable in machines of this kind, combined with the necessary accuracy, and to suit stock-weighing, carts, &c. &c.; yet Mr. James well merits the decision of the judges, his machines being both in principle and practice accurately honest, and now adapted to a variety of farm uses.

Chaff-Cutters.—The prize for this universally necessary machine was again carried off by Mr. Cornes, and for the reasons given in the Report of the Shrewsbury Meeting; but the writer has received no account from the judges of the quantities cut in a given time, nor of the performance and relative properties of the competing engines.

Linseed Crushers.—

Steaming Apparatus.—

Churns.—

Threshing Machines.—

Winnowing Machines.—

Root Washers.—

Steel Flour Mills.—

One-Horse Carts.—

Wheels and Axles.—The writer can give no further account of the perfection of the above enumerated implements than that in the opinion of the judges thereof they merited the prizes and awards accorded to them as the best of their kind in the show-yard; nor is he able to state the extent and nature of the trial or competition to which they were subjected, the judges not having favoured him with any sufficient remarks on the subject, and he having taken no cognizance of the trials or results. He must direct attention to the foregoing list for the names of the exhibitors rewarded.

Horse Hoes.—The judges of the field implements speak in the highest terms of the utility and safe action of Mr. Garrett's often-rewarded implement of this kind for general purposes, considering that, with the steerage and management now adapted to it, and described in former reports, any fairly-skilled workman may be intrusted with it.

As regards turnip-hoes, the judges still consider that produced by Mr. Harkes, of Mere, Cheshire, rewarded both at Southampton and Shrewsbury, to be the best implement of the kind.

Horse Works.—The prize offered for engines of this order was not adjudged, as, although many excellent articles were in the show-yard, no one of them presented sufficient superiority to merit exclusive reward.

Steam-Engine.—The above remarks apply also to the steam-engine, Mr. Cambridge having produced the only one, and this had previously received a prize.

Draining-Tools.—The show-yard was deficient of any articles worthy of notice on this head, and the Society's prize was reserved.

Drain-Tile or Pipe-Machines.—The council would consider it out of place for the writer to give his own opinions on the several ingenious machines for the important purpose of manufacturing drain-tiles and pipes, &c., unassisted by any record or communication of the trials made to him by the judges of that department. He can, therefore, only express his entire agreement in the bestowal of the prize of 20*l.* on Mr. Scragg, of Calveley, near Tarporley, Cheshire, whose machine also took the prize at Shrewsbury, in the report of which meeting an account of it appeared.

It was considerably improved at Newcastle, and so were several of the competing machines; but no one of them, certainly, would be found equal in practical use to Mr. Scragg's.

Mr. Garrett received a judges' award of 5*l.* for a machine invented by Mr. Weller, of Capel, Surrey, which possesses some good properties, and is capable of turning out some very large objects.

The following additional information on the history of the employment of small drain-pipes may not prove uninteresting. The writer had heard from one of his workmen—an old Lincolnshire drainer—that in his youth his father had laid pipes in Sir Thomas Whichcote's grounds of Aswarby, near Sleaford. The story has been confirmed by Sir Thomas Whichcote, who observes—" It is about 40 years since the pipe-tiles were laid in the park here, and up to the present time the drains act well. I am not aware of any of them having stopped or given way, although the land is very flat, and in many places the fall not good. The pipes were made by hand, and tapering, so that one end entered the other, having a clear water-course of two inches in diameter at the small end."

The epoch of the application of pipes to land drainage in Lincolnshire would seem, therefore, to have been nearly concurrent with that by Mr. John Read, at Horsemonden, in Kent.

Mr. Robert Hervey, of Epping, states, that he patented a machine in 1817 for making pipes by vertical pressure, " and in

the year following drained three acres of land with them, and they now act as well or better than they did at first. Those I used were one and a quarter inch bore." Further,—" In my first experiments I pierced holes round about the pipes, and at the latter end of summer, when they had lain about two or three years, a heavy storm came, and I discovered a stoppage. Upon taking up the pipes at that spot I found one nearly filled with hard worm casts, which being cleared out, I have not been further troubled by obstruction." It appears, however, that a neighbour of Mr. Hervey's found some roots had entered by these *flute*-holes in some pipes crossing under a fence. With these exceptions Mr. Hervey's drains are as perfect, and the pipes as sound, as the day they were laid. He, of course, immediately abandoned the vicious practice of boring holes, from the idea that water could not get into the pipes fast enough at the junction of each pair; but this experience of the inutility of holes, and of the injury which may be produced by openings of only a quarter of an inch diameter, shows the attention which drainers should pay to using those pipes only which are well made, and well fitting at their ends.

It has also come to the writer's knowledge that the late Mr. Boulton, of Tew, Oxfordshire, used pipes of one inch bore, three feet long, made of porcelain, by Mr. Wedgwood, of Etruria, for the conveyance of clear spring-water to his house, in the year 1826. The ends of these pipes were closely fitted into each other, being water-tight, and under pressure, the joint having been made by turning one end and boring the other by means of machinery made at the celebrated manufactory of Messrs. Boulton and Watt, of Soho, Birmingham.

Finding these pipes answer so well for conveying water, they were subsequently used plain as at present—without boring and turning the ends—to drain land, and, the writer is informed, with perfect success up to this period.

Clod Crushers and Rollers.—In this department no competitor appeared against Mr. Crosskill's roller, of which he exhibited numerous specimens, varying in size and weight, and adapted to the different purposes to which experience has proved the implement to be usefully applicable. The sum of money placed at the free disposal of the judges being, on this occasion, much more limited than at previous meetings—and no prize having been offered by the Society for rollers of any kind—the judges appended to their list of awards an unanimous expression of the estimate formed by them of the merit of this clod-crusher or roller, including a hope that the Council would reward its inventor with the Society's gold medal for its introduction, and for the several successive improvements made upon it by him.

At a subsequent meeting, the Council, acting upon the recommendation of the judges, conferred this, their highest, mark of distinction upon Mr. Crosskill.

The judges have further remarked in their communications with the writer, that "they consider this implement, with its latest improvement, to be the most beneficial one used in agriculture exhibited at the Newcastle meeting." The improvement thus referred to consists in the enlargement of the eye of each alternate ring, forming collectively the series of rings or discs of which the roller is composed; so that of these rings, which are 23 in number, 12 have eyes fitting the axle just freely enough to revolve upon it, whilst the 11 alternate rings have their eyes enlarged about half an inch more in diameter. This arrangement has added materially to the effect of the implement in abrading and reducing hard clods; it has also induced among the rings a more efficient self-cleaning movement, when the roller is used on moister soils or softer clods; so that, practically, the scope and power of the roller have been augmented, without adding to its cost, or impairing its extreme simplicity; and it can now be employed on soil when in states which would have clogged it, or have diminished its effect if all the rings on the axis had eyes of similar size.*

The superior results arising from this disposition of parts are altogether attributable to what is properly termed *action*—mechanical action; and it has been owing to its possessing this function in so high a degree, that Mr. Crosskill's patent-roller has proved to be more effective in comminuting and compressing soil than the common plain roller, or than the serrate-edged ringed-roller with a square axle, first introduced by him. This property will be better understood by narrating shortly the history of the invention.

The use of rollers for agricultural purposes is probably coeval with, or was immediately subsequent to, that of the plough, or of the rudest stirrer of the soil. The roller is found in countries where agricultural processes are in a purely nascent state. In England, variations have been long since, and advantageously made, both in the materials and construction of the implement. Instead of wood—usually a rounded tree of little weight—rollers have been composed of stone, and of cast or wrought iron; they have also been formed of two, three, or more parts, revolving either on the same axle, or on independent axles. But these, whatever may have been the number or arrangement of their parts, were invariably made plane on their surfaces, until Mr. Crosskill, about the year 1832, imagined the form of roller now

* This improvement was suggested to the patentee by Mr. Robert Neilson, of Halewood, near Liverpool.

under consideration.* His first plan consisted in forming a barrel, by stringing a number of narrow indented rims or discs loosely upon a square axis, the whole revolving, together with the axis, in the journals of the frame. In addition to the saw-like teeth into which the periphery of each rim was divided, other teeth were formed, projecting sideways from the plane of the rim, and in a radial line from the centre, so as to leave no portion of the soil unoperated upon. This roller gradually fought its way into considerable practice, being found to effect a much greater amount of superficial pulverization than the common plain roller. Extended experience disclosed other uses than mere clod-crushing, to which it was applicable; and at the same time pointed out defects which deteriorated its performance and diminished its value. The rolling of young wheat, and spring corn, or other plants, was commenced with it, and usefully; but it was found that, on turning short at the headlands, injury was done by tearing up the soil in the act of turning. A greater scope for turning than is convenient was, therefore, necessary to avoid this evil. Another evil resulted when using it on soils at all damp or sticky, from the adhesion of earth to the teeth and their interstices, which further limited its useful employment. Mr. Crosskill, observing these defects, applied himself to their remedy, and in 1842 he took out a patent for the present implement, the improvements consisting, first, in setting each toothed rim free to revolve separately on a round, instead of their being fitted on a square axle; and secondly, in giving a different form and direction to the lateral teeth. By the first-named alteration the independent action of each rim was secured, so that each rim, in the progressive movement of the whole series, revolves upon its axis, and at the rate exactly due to the space to be travelled over in surmounting the irregularities presented to it; whilst in turning, all tearing of the soil or plants is avoided by the same faculty, which permits every rim or disc to adapt its velocity to the space required for each one to pass over, either forwards or backwards, in the act of turning; in fact, this roller can be turned about on the centre of its axle without producing any injurious effect. The independent motion of the rims also provided a powerful means of self-cleaning; for, inasmuch as the velocity of the several rims is perpetually varying, so they rub off the soil which might otherwise adhere to them—an action now further increased, as before observed, by enlarging the bore of the eye of each alternate ring, which causes a kind of eccentric or up and down

* Spiked rollers are not here referred to, as they cannot accomplish, and are not employed for, the three purposes effected by Mr. Crosskill's single implement, viz. crushing clods, compressing soft soil, and rolling cultivated land.

motion to take place between each pair, and among the whole series of rings or discs.

Mr. Crosskill's square-axle toothed roller first made its appearance in the Society's show-yard at Cambridge in 1840—the round-axled patented machine at Derby in 1843—a premium of 20*l.* was awarded for it by the judges at Southampton in 1844—and it gained the Society's prize of 10*l.* at Shrewsbury in 1845, having on all occasions of trial at the Society's shows greatly excelled the performance of every other roller brought into competition with it. Journal, vol. iv. p. 560, contains a large collection of instances of its utility in arresting the ravages of the wire-worm—an effect owing probably to the forcible bite of the teeth on the ground—in the pulverization of stiff, and compression of light soils, together with the opinions of numerous agriculturists upon its value as a roller of various crops in a state of young growth. Its application to the latter purpose has greatly extended since that period, and the writer may bear his testimony to the success attending its employment on pasture land in destroying the white slug, curing mossyness, and especially in consolidating soft grass-land after drainage. For these latter uses the effect of the implement is greatly enhanced by weighting it to the full extent of the power of the team which can be commanded.

Judges.

William Hesseltine, Worlaby House, Barton, Lincolnshire.
Thomas P. Outhwaite, Bainessee, Catterick, Yorkshire.
Henry Higgins, Brinsop Court, Hereford.
Bryan Millington, Asgarby, Sleaford, Lincolnshire.
John Oakley, Darland, Chatham, Kent.
Nathaniel Blake, Stanton Harcourt, near Ensham, Oxon.

JOSIAH PARKES.

N.B. The readers of the Journal are informed that the names and full addresses of the successful exhibitors of implements are always given in the List of Awards embodied in the Report, which the writer states to save himself endless and vexatious inquiry.—J. P.

END OF VOL. VII.

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Royal Agricultural Society of England.

1846—1847.

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Way, Professor J. Thomas. Royal Agricultural College, Cirencester.

Royal Agricultural Society of England.

GENERAL MEETING,

12, Hanover Square, Friday, May 22, 1846.

REPORT OF THE COUNCIL.

The economy of remunerative farming is one of the great objects of the Royal Agricultural Society of England, and at the same time one of the principal means through which that science included in the terms of their motto is to be derived and regulated; the observation of well established facts, and the results of actual experiments, being the only ground-work on which they admit that improvements in agriculture can be successfully based; while a clear knowledge of cause and effect under given circumstances, and a detail of the particular cases to which such knowledge is applicable, is, in their opinion, the only safe science to be recommended to their members. The theories of chemical agency, physical forces, and organic action, under the varying conditions of local circumstance or the control of vital influence, are in themselves important objects of inquiry for the philosopher; but it is only when the practical application of their results becomes apparent, that they assume a form in which they can be submitted to the test of trial, or be rationally expected to lend any aid in promoting the improvement of practical agriculture. Accordingly, whilst calling in the aid of science to agricultural practice, the Council have felt it their duty to discourage every attempt to introduce vague theories, especially when it has been found by experience that much steady progress may be made in the improvement of agriculture, by the obvious means of applying

to one locality that system of management which has been proved to be successful in another similar locality.

In order to obtain a knowledge of the most approved systems of husbandry practised in different localities, the Society not only holds its Country Meetings, from year to year, in various districts, but incites and remunerates by its prizes for County Reports, and Essays on distinct topics of inquiry, that communication of practical experience which, by publication in the Journal, becomes accessible to the agricultural community. At those Meetings, the knowledge of local excellence, acquired on the spot, is repaid by the exhibition of whatever has been found most desirable in breed of stock, or economical in the construction of implements; and that mutual interchange of opinion amongst farmers themselves which tends to establish a good understanding among all parties connected with agricultural pursuits, and to remove those local prejudices which have so long retarded its progress.

Since the last General Meeting in December, the Council have had under their consideration the details connected with the following general subjects:—

1. The Finances of the Society;
2. The Annual Country Meetings; and
3. The Prizes for Reports and Essays for 1846 and 1847.

Finances.

The Finance Committee have prepared, agreeably with the order of the Council, the first return of a quarterly statement of the receipts and payments, estimated income and liabilities of the Society, which will in future be made at the end of every three months. They have also submitted to the Council their Report on the funded property of the Society, and the arrears of subscription, as well as ther final balance-sheet of the Shrewsbury Meeting account.

The Finance Committee reported, at their last monthly meeting, that the invested capital of the Society consisted of 7000*l.* stock, and that the current cash-balance in the hands of the

bankers amounted to 1482*l.*; and that the arrears of subscription on the 31st of December stood as follows:—

1841	3 Governors at 5*l.* each	. . . . .	£ 15
	321 Members at 1*l.* ,,	. . . . . .	321
1842	4 Governors at 5*l.* ,,	. . . . .	20
	617 Members at 1*l.* ,,	. . . . . .	617
1843	10 Governors at 5*l.* ,,	. . . . .	50
	1094 Members at 1*l.* ,,	. . . . . .	1094
1844	18 Governors at 5*l.* ,,	. . . . .	90
	1582 Members at 1*l.* ,,	. . . . . .	1582
1845	47 Governors at 5*l.* ,,	. . . . .	235
	2702 Members at 1*l.* ,,	. . . . . .	2702
	Total	. . . . .	£6726

76*l.* has been discharged from the arrear account between the last General Meeting on the 3rd of December and the end of that month; and a further reduction of 336*l.* has been effected during the present year. According to the bye-laws, all subscriptions for the current year remaining unpaid on the 1st of June become in arrear, and no member whose subscription is so in arrear is allowed to enjoy any of the privileges of the Society.

Since the last General Meeting in December, 243 new members have been elected, 30 have died, and 81 have been struck off the list, and the Society now consists of—

Life Governors	92
Annual Governors	201
Life Members	554
Annual Members	6105
Honorary Members	19
Total	6971

The Auditors of Accounts on the part of the Society have presented, through the Finance Committee, their report of the Society's accounts to the end of the last half-year, which will be read to you by the Chairman of the Committee.

Country Meetings.

The Council have decided that the Annual Country Meeting of the Society, to be held this year at Newcastle-on-Tyne, shall

take place in the week commencing the 13th of July; Thursday, the 16th of that month, being the principal day of the show, and the day of the Pavilion dinner: and in order to increase the interest and usefulness of the occasion, they have been led by the success of their weekly Council Meetings in London, at which discussions and communications of important matters have so frequently occurred, to give up the Council dinner on the Wednesday, for the purpose of adopting in its place discussion and interchange of opinion, having reference to agricultural topics of practical interest, on a more extended scale, and under distinct regulations for insuring to the members present the opportunity of both acquiring and communicating information. The Council have accordingly arranged that on the evening of Tuesday, the 14th of July, at five o'clock, Professor JOHNSTON, of Durham, one of the honorary members of the Society, will read a paper 'On the Chemical Principles involved in the Preparation of Manures, and their Action upon Crops; with chemical demonstrations;' and on the following evening, at the same hour, Mr. PARKES, the consulting engineer of the Society, will read a paper on the subject of 'Draining;' each of these papers being intended to form only preliminary introductions to the practical discussions which it is hoped will follow their perusal, under such regulations as the President may at the time decide to adopt. The Judges' award of prizes will be read at the close of the discussion on Mr. Parkes's paper.

In addition to the Society's Prizes for "Sheep best adapted to a Mountain District," the Newcastle Local Committee have offered special prizes, under the 27th rule of the Prize-sheet, for Sheep of the Black-faced Breed; and the North-Tyne and Redesdale Cheviot Sheep Show, also special prizes for Sheep of the Cheviot Breed, under the same Rule.

By a distinct regulation, the Council have made it a condition with the exhibitors, that they shall execute all orders for Implements given to them in the Show-yard, at the price stated in their certificates.

The Newcastle Local Committee have undertaken to place the

land for the trial of Implements under the cultivation desired by the Stewards; and are actively engaged in carrying out the various details connected with other departments of the trial.

The mode adopted last year for the appointment of Judges for the Show was found so satisfactory to all parties, that the Council have decided again to act upon it. They have accordingly requested the members of the Society at large to send to the Secretary, or deliver personally to the President, at the General May Meeting, their nomination of persons to act as Judges in any or all of the several departments of the Show; and have appointed two Committees,—one for Judges of Stock, and the other for Judges of Implements,—to select from these nominations, and to report to the Council for confirmation, the names of those gentlemen who, in their opinion, are best qualified to perform those important duties.

The great amount of actual expenses, independently of personal charges and loss of time, incurred by the exhibitors at the Country Meetings of the Society, has frequently engaged the attention of the Council. Last year these expenses were diminished by the liberality of the London and Birmingham, and the Grand Junction Railway Companies, who carried implements and stock to and from the Society's Country Meeting, free of any charge whatever; and the Council have this year the gratifying duty of announcing to the members of the Society, not only a renewal on the part of those two companies of the same most liberal concession, but a free grant of similar privileges in favour of the Society's exhibitors, made by the Great Western, the South-Eastern, and the Newcastle, Shields, and Tynemouth Railway Companies. Other companies, though not granting so entire a freedom of gratuitous transit along their respective lines of railway, have made certain concessions, under special conditions, which the Council have directed to be communicated to the several exhibitors for their information; namely, the South-Western Railway Company consent to convey stock or implements for the Society's show at one-half the usual charges each or either

way, an arrangement which that Company considerately remarks in conveying the grant, "will give the exhibitors the benefit of the reduction, should they sell any of their stock or implements previously to returning from the show:"—the Newcastle and Carlisle Railway Company agree to convey all stock and implements, as well as the persons in charge of them, at half-fares, either going to or returning from the Show; also, in case the Council decide to have any ploughing-match, or other exhibition of practical trial, a few miles from Newcastle, they are willing to convey the ploughs and horses, together with the ploughmen and attendants, to and from the place of such exhibition free of any charge whatever:—the Newcastle and Darlington, and the Midland Counties Railway Companies decline to accept half-fares, but are willing to give a free back-passage to such implements or stock as shall have already paid the full charges in proceeding along their respective lines to the Show.

In order to complete the schedule of information required by the exhibitors, the Council have directed a statement to be drawn out of the various conveyances and rates of charge by Sea from every point of embarkation along the eastern coast to Newcastle-upon-Tyne, where the authorities have obtained for the Society certain reductions in the port dues in favour of exhibitors at the meeting.

At the date when the Council arranged their first succession of the rotation of districts for the Country Meetings, ending with the South Wales district as the one intended for the meeting of 1847, they had not ascertained by actual experience the indispensable necessity of railway accommodation. With a knowledge of the absence of adequate railway accommodation throughout South Wales, and the consideration that the Bristol Meeting of 1842, and the Shrewsbury Meeting of 1845 had been held within the reach of the Principality, the Council have felt themselves compelled to abandon their intention of holding the meeting of the Society for 1847 in the South Wales district.

The Council have decided on the following as the districts of

the Country Meetings for the ensuing four years, and have resolved that every year a new district shall be added in advance to compensate for the one which will annually elapse:—

1847.—The South Midland District (comprised of the counties of Bedford, Berks, Buckingham, Hertford, Huntingdon, Northampton, Oxford, and Warwick).

1848.—The Yorkshire District (comprised of the county of York).

1849.—The Eastern District (comprised of the counties of Essex, Suffolk, Norfolk, and Cambridge).

1850.—The Western District (comprised of the counties of Wilts, Dorset, Somerset, Devon, and Cornwall).

The Council have accepted the invitation of the authorities of Northampton to hold the Country Meeting of the Society for 1847 at that town; and already the Mayor and Corporation, under the great seal of the borough, have granted to the Society such liberal accommodation for the occasion, as to give reason to hope that the Northampton Meeting will prove in every respect a most successful and important one. In order to ascertain more fully the local feeling on the subject of the prizes offered for any particular year, the Council have, by an alteration in their bye-laws, postponed the final settlement of their prize-sheet from June to December in the year previous to that of a Country Meeting at which such prizes are to be awarded. Accordingly the prizes for the Northampton Meeting will not be finally settled until the month of December, 1846. In the meantime a preliminary prize-sheet for that occasion is laid before the members at their present General Meeting, for the purpose of receiving from them such suggestions as they may think proper to make to the Council.

Report and Essay Prizes.

The Journal Committee have reported the several Essays, required to be sent in for competition by the 1st of March last, to which the Judges have awarded the Prizes offered by the Society; namely,—

To THOMAS ROWLANDSON, of Liverpool, the Prize of Fifty Sovereigns for the best Report on the Farming of North Wales.

To SAMUEL JONAS, of Ickleton, Cambridgeshire, the Prize of Fifty Sovereigns for the best Report on the Farming of Cambridgeshire.

To JOHN BRAVENDER, of Cirencester, the Prize of Fifty Sovereigns for the best Report on the Advantages or Disadvantages of Breaking up Grass-land.

To GEORGE NICHOLLS, of Hyde Park Street, London, the Prize of Thirty Sovereigns for the best Essay on the Improvement of the Condition of the Agricultural Labourer, so far as it may be promoted by private exertion without legislative enactment.

To HUGH RAYNBIRD, of Hengrave, Suffolk, the Prize of Twenty Sovereigns for the best Account of Measure-Work, locally known as Task, Piece, Job, or Grate work, in its application to agricultural labour.

To W. C. SPOONER, of Southampton, the Prize of Ten Sovereigns for the best Account of the Use of Superphosphate of Lime produced with Acid and Bones for Manure.

To T. C. BURROUGHES, of Gazeley, Cambridgeshire, the Prize of Ten Sovereigns for the best Account of the Cultivation of White Mustard.

To WM. LINTON, of Sheriff Hutton, Yorkshire, the Prize of Ten Sovereigns for a description of the best method of Draining Running Sands.

The Judges on the sixteen Essays on the Keeping of Farming Accounts having reported that none of the Essays are worthy of the Prize offered by the Society in that class, the Council have appointed a Committee to report on the best mode in their opinion in which a practical farmer may be enabled in the simplest manner to keep the requisite accounts connected with his farming establishment. The Council are indebted to the kindness of Mr. JOHN CLARKE, of Long Sutton, Lincolnshire, in having placed at the disposal of the Journal Committee his Essay on Grass Lands, commended by the Judges.

The Council have adopted the following schedule of subjects and amount of prizes for the Reports and Essays of next year, subject to such conditions as will hereafter, in due time, be published :—

On the Farming of Northumberland	£ 50
On the Farming of Suffolk	50
On the Farming of Somersetshire	50
On the Management of Sheep	20
On the Cultivation of Wheat	20
On the Cultivation of Mangold Wurzel	20
On Paring and Burning	10
On Flax	20
On the Great Level of the Fens, history of the drainage, view of its present state, and account of the defects which still require to be remedied	50
For an account of the best Manure for Wheat, compounded of chemical ingredients, to be tried by Judges appointed by the Society	30
For an account of the best Manure for Turnips, compounded of chemical ingredients, to be tried by Judges appointed by the Society	30

The Council have adopted the following regulations in reference to any question of disputed patent-right that may be made by exhibitors of such implements as may be selected by the Judges for trial, namely, "That the Stewards of the Yard, on receiving a notice in writing that any invention is considered to be an infringement of the right of another party, shall be directed to inform the exhibitor that he will be at liberty to direct the trial, under the inspection of the Judges; and if, on such trial, his invention should be found to merit the prize, the prize shall be awarded, subject to the condition of payment being suspended for a reasonable period, to allow the trial of the rights of the parties at law; and that if no steps at law are taken in the next term, the award shall be absolute."

The Council, judging from the entry of stock and implements already made, have every reason to anticipate an extremely good meeting at Newcastle; and, in conclusion, have not only to report the continual accession of new Members from every part of the kingdom, but to congratulate the Society on the steady progress made in the gradual development of its established principles, and in the attainment of a more exact knowledge, derived from

experience of the means best adapted to ensure their advancement. The Council rely with confidence on the continued support and co-operation of all the Members of the Society, and trust they will thereby secure the prosperity of this great national institution.

By order of the Council,

(Signed) JAMES HUDSON,
Secretary.

General Meetings of 1846–7.

The General December Meeting, in London, on Saturday, December 12, 1846.

The General May Meeting, in London, on Saturday, May 22, 1847.

The Annual Country Meeting, at Northampton, in 1847.

Cottage Economy.—Mr. Main's article on Cottage Gardening, and Mr. Burke's compilation on Cottage Economy and Cookery, have each been reprinted from the Journal in a separate form, for cheap distribution. Either or both of these tracts may be obtained by members at the rate of 1*s.* per dozen copies, on their enclosing to the Secretary a Post-office money-order for the number required; at the same time stating the most eligible mode of conveyance by which the copies can be transmitted to their address. They are also sold to the public at 2*d.* each, by the Society's Publisher, Mr. Murray, 50, Albemarle Street, London.

Volumes of the Journal.—The first Volume of the Journal consists of *four* parts, the second and third Volumes of *three* parts each (the second and third parts of the third Volume being comprised in a double number), and the fourth of *two* parts. The Journal is now published half-yearly, namely, the first half-volume for each year about the beginning of July, and the second about the end of December or beginning of January.

Subscriptions may be paid to the Secretary, in the most direct and satisfactory manner, by means of Post-office orders, to be obtained on application at any of the principal Post-offices throughout the kingdom. They are due in advance, for each year, on the 1st of January; and are in arrear if unpaid by the 1st of June ensuing. No Member is entitled to the Journal, or to any other privileges of the Society, whose subscription is in arrear.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Half-yearly Account ending 31st Dec., 1845.

RECEIPTS.	£.	s.	d.
Balance in the hands of the Bankers, 30th June, 1845	3912	11	7
Ditto in the hands of the Secretary, 30th June, 1845	4	9	2
Dividends on Stock	129	7	4
Life Compositions of Governors	40	0	0
Life Compositions of Members	331	0	0
Annual Subscriptions of Governors	60	0	0
Annual Subscriptions of Members	1122	6	0
Sale of Journal	152	18	0
Sale of Cottage Tracts	2	16	4
Receipts during the half-year on account of the Country Meetings	349	18	1
Lord Kenyon's Prize for Essay on Gorse	20	0	0
	£6125	6	6

(Signed) THOMAS AUSTEN, Chairman.
THOMAS RAYMOND BARKER,
C. B. CHALLONER.

PAYMENTS.	£.	s.	d.
Permanent Charges	260	12	6
Taxes and Rates	17	1	2
Establishment Charges	423	18	6
Postage and Carriage	17	10	11
Advertisements	13	3	6
Expenses of Journal	706	12	1
Prizes	1268	14	6
Lord Kenyon's Prize for Essay on Gorse	20	0	0
Payments during the half-year on account of the Country Meetings	2607	9	8
Subscriptions repaid	3	0	0
Miscellaneous items of Payment	3	8	6
Balance in the hands of the Bankers, 31st Dec., 1845	769	2	5
Ditto in the hands of the Secretary, 31st Dec., 1845	14	12	9
	£6125	6	6

Examined and audited this 15th day of May, 1846.

(Signed) CHAS. TAWNEY.
THOMAS KNIGHT.
C. H. TURNER.

SPECIAL COUNTRY MEETING ACCOUNT: SHREWSBURY, 1845.

Receipts.	£.	s.	d.	Payments.	£.	s.	d.
Subscription from Shrewsbury	1000	0	0	Dinners	871	11	6
Dinner Tickets	730	3	0	Pavilion	565	0	0
Show-yard Receipts	1682	19	5	Show-yard and Trial of Implements	2269	14	10
Sale of Catalogues	256	15	6	Police	162	1	0
Excess of Payments over Receipts at the Shrewsbury Meeting, chargeable on the general Funds of the Society	1736	7	2	Judges	362	16	0
				Consulting Engineer	78	1	0
				Auctioneer	21	0	0
				Printing	435	1	7
				Stationery	33	7	9
				Advertisements	390	17	0
				Postage and Carriage	35	14	6
				Official Staff	37	17	2
				Extra Clerks, &c.	7	17	0
				Omnibus Proprietors	130	0	0
				Loss on light gold	5	5	9
	£5406	5	1		£5406	5	1

(Signed) THOMAS AUSTEN, Chairman.
THOMAS RAYMOND BARKER.
C. B. CHALLONER.

Meeting at Newcastle-upon-Tyne.

PRINCIPAL DAY OF THE SHOW, JULY 16, 1846.

AWARD OF PRIZES.

CATTLE: I. *Short-Horns.*

JOHN MASON HOPPER, of Newham Grange, near Stockton-upon-Tees: the Prize of FORTY SOVEREIGNS, for his 3 years and nearly 2 months-old Short-horned Bull; bred by himself.

WILLIAM RAINE, of Morton Tinmouth, near Darlington: the Prize of FIFTEEN SOVEREIGNS, for his 3 years and 9 months-old Pure Short-horned Bull; bred by himself.

THOMAS WETHERELL, of Durham: the Prize of TWENTY SOVEREIGNS, for his 2 years and 5 months-old Short-horned Bull; bred by William Hutton, of Gate Burton, near Gainsborough.

RICHARD BOOTH, of Warlaby, near Northallerton: the Prize of FIFTEEN SOVEREIGNS, for his 3 years 2 months and 8 days-old Short-horned Cow; bred by himself.

JOHN BOOTH, of Killerby, near Catterick: the Prize of FIFTEEN SOVEREIGNS, for his 2 years 2 months and 3 weeks-old Short-horned in-calf Heifer; bred by himself.

JAMES BANKS STANHOPE, of Revesby Abbey, near Boston: the Prize of TEN SOVEREIGNS, for his 1 year 4 months and 26 days-old Short-horned Heifer; bred by himself.

JAMES BANKS STANHOPE, of Revesby Abbey, near Boston: the Prize of TEN SOVEREIGNS, for his 9 months and 28 days-old Short-horned Bull-Calf; bred by himself.

CATTLE: II. *Herefords.*

EDWARD GOUGH, of Gravel Hill, near Shrewsbury: the Prize of FORTY SOVEREIGNS, for his 3 years and 7 months-old Hereford Bull; bred by the late Edward Gough, of Gravel Hill.

Edward Williams, of Lowes Court, near Hay, Herefordshire: the Prize of Fifteen Sovereigns, for his 3 years 8 months and 16 days-old Hereford Bull; bred by John Nelson Carpenter, of Eardisland, Herefordshire.

John Nelson Carpenter, of Eardisland, near Leominster: the Prize of Twenty Sovereigns, for his 1 year 5 months and 3 days-old Hereford Bull; bred by David Williams, of Newton, near Brecon.

Charles Walker, of Sutton, near Tenbury: the Prize of Fifteen Sovereigns, for his 7 years and 4 months-old Hereford Cow; bred by himself.

John Nelson Carpenter, of Eardisland, near Leominster: the Prize of Ten Sovereigns, for his 1 year and 10 months-old Hereford Heifer; bred by himself.

John Nelson Carpenter, of Eardisland, near Leominster: the Prize of Ten Sovereigns, for his 8 months and 8 days-old Hereford Bull-Calf; bred by himself.

Cattle: III. *Devons.*

George Turner, of Barton, near Exeter: the Prize of Forty Sovereigns, for his 3 years and 8 months-old pure North Devon Bull; bred by himself.

Thomas White Fouracre, of Durston, near Taunton: the Prize of Fifteen Sovereigns, for his 2 years and 9 months-old Devon Bull; bred by himself.

Thomas Bond, of Bishop's-Lydeard, near Taunton: the Prize of Twenty Sovereigns, for his 2 years and 5 months-old Devon Bull; bred by Merion, of North Molton, near Exeter.

Thomas White Fouracre, of Durston, near Taunton: the Prize of Fifteen Sovereigns, for his 4 years and 5 months-old Devon Cow; bred by himself.

George Turner, of Barton, near Exeter: the Prize of Fifteen Sovereigns, for his 2 years and 1 month-old Pure North-Devon in-calf Heifer; bred by himself.

Thomas White Fouracre, of Durston, near Taunton: the Prize of Ten Sovereigns, for his 1 year and 5 months-old Devon Heifer; bred by himself.

Thomas Bond, of Bishop's-Lydeard, near Taunton: the Prize of Ten Sovereigns, for his 4 months-old Devon Bull-Calf; bred by himself.

CATTLE: IV. *Any Breed* (not qualified to compete in the foregoing Classes).

HON. M. W. B. NUGENT, of Higham Grange, near Hinckley, Leicestershire: the Prize of TWENTY-FIVE SOVEREIGNS, for his 5 years and 1 month-old Pure Leicester or Long-horned Bull; bred by J. Twycross, of Canley, near Coventry.

JOHN MARSHALL, of Long Park, Scaleby, near Carlisle: the Prize of TEN SOVEREIGNS, for his 7 years and 10 months-old Pure Galloway Bull; bred by Thomas Wannop, of Holme House.

HON. M. W. B. NUGENT, of Higham Grange: the Prize of FIFTEEN SOVEREIGNS, for his 1 year 4 months and 1 day-old Pure Leicester or Long-horned Bull; bred by himself.

HON. M. W. B. NUGENT, of Higham Grange: the Prize of FIFTEEN SOVEREIGNS, for his 3 years 10 months and 18 days-old Pure Leicester or Long-horned Cow; bred by himself.

HON. M. W. B. NUGENT, of Higham Grange: the Prize of TEN SOVEREIGNS, for his 2 years 7 months and 24 days-old Pure Leicester or Long-horned in-calf Heifer; bred by himself.

Hon. M. W. B. NUGENT, of Higham Grange: the Prize of TEN SOVEREIGNS, for his 1 year 6 months and 26 days-old Pure Leicester or Long-horned Heifer; bred by himself.

HORSES.

NATHANIEL BARTHROPP, of Cretingham Rookery, near Woodbridge: the Prize of FORTY SOVEREIGNS, for his 6 years-old Cart Stallion; bred by the late H. Bennington, of Framlingham, Suffolk.

THOMAS RICHARDSON, of Solemain, near Brampton, Cumberland: the Prize of FIFTEEN SOVEREIGNS, for his 7 years-old Cart Stallion; bred by John Turling, of Chapeltown, Cumberland.

FREDERICK THOMAS BRYAN, of Knossington, near Oakham: the Prize of FIFTEEN SOVEREIGNS, for his 3 years-old Cart Stallion; bred by Richard Brown, of Elsworth, Cambridgeshire.

EDWARD MILLS, of Molesden, near Morpeth: the Prize of FIFTEEN SOVEREIGNS, for his 2 years-old Cart Stallion; bred by Ann Marshall, of Stannington, near Morpeth.

LORD ST. JOHN, of Melchbourne, near Higham Ferrers: the Prize of TWENTY SOVEREIGNS, for his Cart Mare and Foal; the sire of the Foal being his own property.

THOMAS FORSTER, of Scrainwood, near Rothbury, Northumberland: the Prize of TEN SOVEREIGNS, for his 2 years-old Filly; bred by himself.

GEORGE HOLMES, of Thirsk, Yorkshire: the Prize of THIRTY SOVEREIGNS, for his 4 years-old Thorough-bred Stallion; bred by John Scott, of White Wall House, near Malton, Yorkshire. Got by Voltaire; dam Cyprian.

SHEEP: I. *Leicesters.*

GEORGE TURNER, of Barton, near Exeter: the Prize of FORTY SOVEREIGNS, for his 15 months-old Pure Leicester Ram; bred by himself.

ROBERT SMITH, of Burley-on-the-Hill, near Oakham: the Prize of FIFTEEN SOVEREIGNS, for his 16 months-old Pure Leicester Ram; bred by himself.

ROBERT BURGESS, of Cotgrave Place, near Nottingham: the Prize of THIRTY SOVEREIGNS, for his 53 months-old Leicester Ram; bred by himself.

THOMAS EDWARD PAWLETT, of Beeston, near Biggleswade: the Prize of FIFTEEN SOVEREIGNS, for his 40 months-old Leicester Ram; bred by himself.

GEORGE ANGAS, of Neswick, near Driffield, Yorkshire: the Prize of TEN SOVEREIGNS, for his pen of five 16 months-old Leicester Shearling Ewes; bred by Caleb Angas, of Neswick.

SHEEP: II. *Southdowns.*

JONAS WEBB, of Babraham, near Cambridge: the Prize of FORTY SOVEREIGNS, for his 16 months-old Southdown Ram; bred by himself.

JONAS WEBB, of Babraham, near Cambridge: the Prize of FIFTEEN SOVEREIGNS, for his 16 months-old Southdown Ram; bred by himself.

JONAS WEBB, of Babraham, near Cambridge: the Prize of THIRTY SOVEREIGNS, for his 28 months-old Southdown Ram; bred by himself.

His Grace the DUKE of RICHMOND, of Goodwood, near Chichester: the Prize of FIFTEEN SOVEREIGNS, for his 28 months-old Southdown Ram; bred by himself.

His Grace the DUKE of RICHMOND, of Goodwood: the Prize of TEN SOVEREIGNS, for his pen of five 16 months-old Southdown Shearling Ewes; bred by himself.

E. G. BARNARD, M.P., of Gosfield Hall, near Halstead, Essex: the Prize of FIVE SOVEREIGNS, for his pen of five 16 months-old Southdown Shearling Ewes; bred by himself.

Sheep: III. *Long-Wools (Not qualified to compete as Leicesters).*

Charles Large, of Broadwell, near Lechlade, Gloucestershire: the Prize of Forty Sovereigns, for his 16 months-old New Oxfordshire Ram; bred by himself.

Edward Handy, of Sevenhampton, near Andoversford, Gloucestershire: the Prize of Fifteen Sovereigns, for his 16 months-old Improved Cotswold Ram; bred by himself.

Edward Handy, of Sevenhampton: the Prize of Thirty Sovereigns, for his 40 months-old Improved Cotswold Ram; bred by himself.

Charles Large, of Broadwell: the Prize of Fifteen Sovereigns, for his 28 months-old New Oxfordshire Ram; bred by himself.

Edward Smith, of Charlbury, near Enstone, Oxfordshire: the Prize of Ten Sovereigns, for his pen of five 16 months-old Long-woolled Oxfordshire Ewes; bred by himself.

Sheep: IV. *Mountain Breed.*

Isaac William Bolam, of Fawdon, near Whittingham, Northumberland; the Prize of Twenty Sovereigns, for his 39 months-old pure Cheviot Ram; bred by himself.

William Forster, of Burradon, near Rothbury, Northumberland; the Prize of Ten Sovereigns, for his 27 months-old pure Cheviot Ram; bred by himself.

Thomas Elliot, of Hindtrope, near Jedburgh, Roxburghshire; the Prize of Ten Sovereigns, for his pen of Five 14 months-old pure Cheviot Shearling Ewes; bred by himself.

Thomas Elliot, of Hindtrope, near Jedburgh; the Prize of Ten Sovereigns, for his pen of Five 63 months-old pure Cheviot Ewes; bred by himself.

Pigs.

Richard Hobson, of Park House, Leeds; the Prize of Fifteen Sovereigns, for his 2 years and 1 month-old Boar of a large Breed; bred by William Nightingale, of Hilton, near Cleveland, Yorkshire.

William Mauleverer, of Arncliffe Hall, Cleveland, Yorkshire; the Prize of Five Sovereigns, for his 1 year and 10 months-old Yorkshire Boar of a large breed; bred by himself.

Ashley H. Wilson, of the Abbey near Wigton, Cumberland; the Prize of Fifteen Sovereigns, for his 1 year and 3 months-old Boar of a small breed; bred by Sober Watkin, of Plumpton, near Penrith.

ROBERT JAMES, of Chalkside, near Wigton, Cumberland; the Prize of FIVE SOVEREIGNS, for his 1 year and 6 months-old Boar of a small breed; bred by himself.

CHARLES JACKSON, of Foss Gate, York; the Prize of TEN SOVEREIGNS, for his 2 years and 6 months-old Sow of a large breed; breeder unknown.

RICHARD HOBSON, of Park House, Leeds; the Prize of TEN SOVEREIGNS, for his 3 years-old Sow of a small breed; bred by the Rev. C. G. Smith, of Everton.

WILLIAM FISHER HOBBS, of Marks Hall, near Kelvedon, Essex; the Prize of TEN SOVEREIGNS, for his pen of Three 31 weeks and 1 day-old Sow Pigs of the same litter; bred by himself.

WOOL.

THOMAS MADDISON, of Wandon, near Belford, Northumberland; the Prize of TEN SOVEREIGNS, for his sample of 10 Fleeces of pure Leicester Long Wool, shorn from sheep not housed, fed on turnips.

THOMAS ELLIOT, of Hindtrope, near Jedburgh, the prize of TEN SOVEREIGNS, for his Sample of 10 Fleeces of pure Cheviot Short Wool, shorn from sheep not housed, fed entirely on mountain pasture.

WILLIAM ELLISON, of Sizergh Castle, near Kendal, the Prize of TEN SOVEREIGNS, for his Sample of 10 Fleeces of Sizergh fell Down and Leicester Mixed Wool, shorn from Sheep not housed, fed on turnips and grass.

BLACK-FACED SHEEP.

CHARLES SUMMERS, of Parkhead, Whitfield, Cumberland; the Prize of TEN SOVEREIGNS, offered by the Newcastle Local Committee, for his 15 months-old pure Black-faced Shearling Ram; bred by himself.

HENRY PHILLIPSON, of Allenheads, near Allendale, Northumberland; the Prize of FIVE SOVEREIGNS, offered by the Newcastle Local Committee, for his 14 months-old pure Black-faced Shearling Ram; bred by himself.

HENRY PHILLIPSON, of Allenheads, near Allendale; the Prize of FIVE SOVEREIGNS, offered by the Newcastle Local Committee, for his 3 years and 3 months-old pure Black-faced Ram, bred by Thomas Nattrass, of Allenheads.

CHARLES SUMMERS, of Parkhead, Whitfield, Cumberland; the Prize of FIVE SOVEREIGNS, offered by the Newcastle Local Committee, for his 3 years and 3 months-old pure Black-faced Ram; bred by himself.

William Dodd, of Padaburn, near Bellingham, Northumberland; the Prize of Five Sovereigns, offered by the Newcastle Local Committee, for his pen of Five 14 months-old Black-faced Highland Ewes; bred by himself.

Pure Cheviot Sheep.

John Robson, of East Kielder, near Bellingham, Northumberland; the Prize of Ten Sovereigns, offered by the North Tyne and Redesdale Cheviot Sheep Show, for his pen of Three 15 months-old pure Cheviot Shearling Rams; bred by himself.

Henry Thompson, of Ranshope, near Newcastle-upon-Tyne; the Prize of Five Sovereigns, offered by the North Tyne and Redesdale Cheviot Sheep Show, for his pen of Three 15 months-old pure Cheviot Shearling Rams; bred by himself.

EXTRA STOCK.

John Booth, of Killerby, near Catterick, Yorkshire; the sum of Four Sovereigns, for his 9 years and 5 months-old Short-Horned Cow; bred by himself.

John Booth, of Killerby, near Catterick; the sum of Two Sovereigns, for his 5 years and 2 months-old Short-Horned Cow; bred by himself.

Thomas Crofton, of Holywell, near Durham; the sum of One Sovereign, for his 7 years and 2 months-old Short-horned Cow; bred by John Colling, of White House.

Thomas Wetherell, of Durham; the sum of One Sovereign, for his 8 months-old Short-Horned Heifer Calf; bred by himself.

Thomas Wilson, of Shotley Hall, near Newcastle-upon-Tyne; the sum of Two Sovereigns, for his 4 years and 3 months-old Short-Horned Heifer; bred by himself.

George D. Trotter, of Bishop-Middleham, near Darlington; the sum of Five Sovereigns, for his 1 year-old Stallion Colt; bred by himself; got by Cain, dam a Cleveland mare.

John Clarke, of Long Sutton, Lincolnshire; the sum of Three Sovereigns, for his 4 years and 3 months-old Improved Long Woolled Ewe; bred by William Clark, of Fleet, Lincolnshire.

Thomas Maddison, of Wandon, near Belford, Northumberland; the sum of Five Sovereigns, for his pen of Five 2 years and 3 months-old pure Leicester Ewes; bred by himself.

IMPLEMENTS.

John Howard, of Bedford, for the best Plough adapted to heavy land, Ten Sovereigns.

John Howard, of Bedford, for the best Plough adapted to light land, Ten Sovereigns.

Richard Hornsby, of Spittlegate, Grantham, for the best Drill for general purposes, and also for distributing compost in a moist or dry state, Fifteen Sovereigns.

Thomas Hunter, of Ulceby, near Barrow-on-Humber, for the best Turnip Drill on the flat, and also for distributing compost in a moist or dry state, Ten Sovereigns.

John Teasdale, of Burneston, near Bedale, for the best Turnip Drill on the ridge, and also for distributing compost in a moist or dry state, Ten Sovereigns.

William Crosskill, of the Beverley Iron Works, Beverley, Yorkshire, for the best Scarifier, Ten Sovereigns.

John Cornes, of Barbridge, near Nantwich, for the best Chaff Cutter, Ten Sovereigns.

Thomas Scragg, of Calveley, near Tarporley, for the best machine for making Draining Tiles or Pipes, Twenty Sovereigns.

Richard Coleman, of Colchester, for the best Harrow, Five Sovereigns.

Richard Hornsby, of Spittlegate, near Grantham, for the best Drill Presser, depositing manures and seed, Ten Sovereigns.

Richard Robinson, of Lisburn, county Antrim, for the best Churn, Five Sovereigns.

James and Co., of 44, Fish Street Hill, London, for the best Weighing Machine for farm produce and live cattle, Ten Sovereigns.

Richard Robinson, of Lisburn, county Antrim, for the best Steaming Apparatus for Roots, Five Sovereigns.

John Read, of 35, Regent Circus, Piccadilly, London, for the best Subsoil Pulverizer, Ten Sovereigns.

Dalrymple Crawford, of Moseley Road, Birmingham, for the best Hand-seed Dibble, Five Sovereigns.

William Crosskill, of the Beverley Iron Works, Beverley, Yorkshire, for the best Linseed Crusher, Five Sovereigns.

WILLIAM CROSSKILL, of the Beverley Iron Works, Beverley, Yorkshire, for the best One Horse Cart, FIVE SOVEREIGNS.

RICHARD GARRETT, of Leiston Works, Saxmundham, Suffolk, for the best Threshing Machine, TWENTY-FIVE SOVEREIGNS.

EDWARD PIERCE, of Llanasa, near Holywell, Flintshire, for his Hay-band Maker, TWO SOVEREIGNS.

ZACHARIAH PARKES, of Birmingham, for his Corn Crusher, THREE SOVEREIGNS.

RICHARD HORNSBY, of Spittlegate, Grantham, for his Winnowing Machine, THREE SOVEREIGNS.

RICHARD ROBINSON, of Lisburn, county Antrim, for Rowan's Patent Axle, FIVE SOVEREIGNS.

JOSEPH COOK GRANT, of Stamford, Lincolnshire, for his Patent Lever Horse Hay Rake, THREE SOVEREIGNS.

H. SMITH and Co., of Stamford, Lincolnshire, for their Haymaking Machine, FIVE SOVEREIGNS.

RICHARD STRATTON, of Bristol, for his Norwegian Harrow, FIVE SOVEREIGNS.

RICHARD GARRETT, of Leiston Works, Saxmundham, Suffolk, for his Tile Machine, FIVE SOVEREIGNS.

H. SMITH and Co., of Stamford, Lincolnshire, for their Grubber or Improved Land Cultivator, SILVER MEDAL.

BARRETT and ASHTON, of Hull, for their Spike Roller or Revolving Harrow, SILVER MEDAL.

WILLIAM CROSSKILL, of the Beverley Iron Works, Beverley, Yorkshire, for his Patent Wheels and Axle, SILVER MEDAL.

RICHARD GARRETT, of Leiston Works, Saxmundham, Suffolk, for his Kent Drill, SILVER MEDAL.

JAMES RICHMOND, of Salford, Manchester, for his Root and Vegetable Washer, SILVER MEDAL.

EGERTON W. HARDING, of Old Springs, near Market Drayton, Salop, for his Set of Whipple Trees, SILVER MEDAL.

Commendations.

*Thomas Crofton, of Holywell, near Durham: for his 7 years and 8 months-old Short Horned Bull; bred by Colonel Cradock, of Hartforth.

*Charles Whitfield Harvey, of Walton on the Hill, near Liverpool: for his 4 years and 7 months-old Short-Horned Bull; bred by himself.

*John Forrest, of Stretton, near Warrington, Lancashire: for his 2 years and 4 months-old Short-Horned Bull; bred by —— Woodhouse, of ———.

*His Grace the Duke of Buccleuch, of Dalkeith Park, Dalkeith, Mid Lothian: for his 9 years-old Short-Horned Cow; bred by himself.

*F. H. Fawkes, of Farnley, near Otley, Yorkshire: for his 6 years and 9 months-old pure Short-Horned Cow; bred by Jonas Whitaker, of Green Holme, near Otley.

*John Forrest, of Stretton, near Warrington, Lancashire: for his 6 years and 1 month-old pure Short-Horned Cow; bred by himself.

*Richard Booth, of Warlaby, near Northallerton, Yorkshire: for his 2 years and 3 months-old Short-Horned Heifer; bred by himself.

*The Right Hon. Lord Feversham, of Duncombe Park, near Helmsley, Yorkshire: for his 2 years and 10 months-old pure Short-horned Heifer; bred by himself.

*Thomas Wetherell, of Durham: for his 2 years and 3 months-old Short-Horned Heifer; bred by William Wetherell, of Durham.

George D. Trotter, of Bishop-Middleham, near Darlington: for his 1 year and 6 months-old Short-Horned Heifer; bred by himself.

The Right Hon. Lord St. John, of Melchbourne, near Higham Ferrers, Northamptonshire: for his 3 years-old Cart Stallion; bred by himself.

*Richard Ferguson, of Harker Lodge, near Carlisle: for his 10 years-old thorough bred Stallion; bred by the Earl of Jersey. Got by Buzzard, dam, Cobweb.

*John Foxton, of Waitwith, near Richmond, Yorkshire: for his 14 years-old thorough-bred Stallion; bred by John Rocliffe of Aisenby, near Topcliffe, Yorkshire. Got by Old President, dam by Akarius.

*Robert Burgess, of Cotgrave Place, near Nottingham: for his 41 months-old Leicester Ram; bred by himself.

*Robert Burgess, of Cotgrave Place: for his 53 months-old Leicester Ram; bred by himself.

*Robert Burgess, of Cotgrave Place: for his 53 months-old Leicester Ram; bred by himself.

Thomas Edward Pawlett, of Beeston, near Biggleswade, Bedfordshire: for his 28 months-old Leicester Ram; bred by himself.

Thomas Edward Pawlett, of Beeston, near Biggleswade: for his 28 months-old Leicester Ram; bred by himself.

Thomas M. Goodlake, of Wadley House, near Faringdon, Berkshire: for his 17 months-old pure Southdown Ram; bred by himself.

*Jonas Webb, of Brabaham, near Cambridge: for his 16 months-old Southdown Ram; bred by himself.

Jonas Webb, of Babraham, near Cambridge: for his 16 months-old Southdown Ram: bred by himself.

His Grace the Duke of Richmond, of Goodwood Park, Sussex: for his 28 months-old Southdown Ram; bred by himself.

David Barclay, M.P., of Eastwick Park, near Leatherhead, Surrey: for his Pen of Five 15 months-old Southdown Shearling Ewes; bred by himself.

Charles Large, of Broadwell, near Lechlade, Gloucestershire: for his 28 months-old New Oxfordshire Ram; bred by himself.

*Edward Smith, of Charlbury, near Eustone, Oxon: for his 53½ months-old Long-wooled Oxfordshire Ram; bred by himself.

**Robert Graham, of Hetherside, Cumberland: for his 2 years and 2 months-old Boar of a large breed; bred by William Glaster, of High House, Cumberland.

George Lowes Ridley, of Banks Hall, near Barnsley, Yorkshire: for his 1 year 10 months and 17 days-old Boar of a large breed; bred by himself.

William Ellison, of Sizergh Castle, near Kendal, Westmoreland: for his 18 weeks-old Sizergh Boar of a small breed; bred by himself.

*William Fisher Hobbs, of Marks Hall, near Kelvedon, Essex: for his 1 year 2 months and 24 days-old Improved Essex Boar, of a small breed; bred by himself

William Fisher Hobbs, of Marks Hall, Essex: for his 12 months and 24 days-old Improved Essex Boar, of a small breed; bred by himself.

*Richard Hobson, of Park House, Leeds: for his 10 months-old Boar, of a small breed; bred by the Rev. C. G. Smith, of Everton.

*John Mason Hopper, of Newham Grange, near Stockton-upon-Tees: for his 1 year and nearly 8 months-old Boar, of a small breed; bred by J. Peacock, of Hart.

*Rev. Cornelius Thompson, of Elkesley, near East Retford, Nottinghamshire: for his 7 months-old-Boar of a small breed; bred by himself.

*His Grace the Duke of Northumberland, of Alnwick Castle, Northumberland: for his 3 years and 8 months-old Northumberland Sow, of a large breed; bred by J. Turnbull, of Brunton, near Alnwick.

John Walton Nutt, of York: for his 1 year and 11 months-old Sow, of a large breed; bred by J. Fetherstonhaugh, of Kirkoswald.

*George D. Trotter, of Bishop-Middleham, near Darlington: for his 3 to 4 years-old Sow of a large breed; bred by himself.

Rev. John Higginson, of Thormanby, near Thirsk, Yorkshire: for his 3 years and 6 months-old Improved Leicester Sow, of a small breed; bred by himself.

**Richard Hobson, of Park House, Leeds: for his 10 months-old Sow, of a small breed: bred by himself.

*William Fisher Hobbs, of Mark's Hall, Essex: for his 7 months and 18 days-old Improved Essex Sow, of a small breed; bred by himself.

William Hunt, of Dilston, near Hexham, Northumberland: for his 3 years-old Sow, of a small breed; breeder unknown.

John March, of Greenside, near Ryton, Durham: for his 8 months and 16 days-old Sow, of a small breed; bred by himself.

John March, of Greenside, near Ryton, Durham: for his 7 months and 11 days-old Sow, of a small breed; bred by himself.

*William Russell, of Brancepeth, near Durham: for his 5 years-old Sow of a small breed; bred by Thomas Crofton, of Holywell, near Durham.

Timothy Smith, of Holyland Hall, near Sheffield: for his 2 years and 1 month-old Sow, of a small breed; bred by the Rev. Charles George Smith, of Everton.

Rev. Cornelius Thompson, of Elkesley, near East Retford, Nottinghamshire: for his 7 months-old improved Nottinghamshire and Berkshire Sow, of a small breed; bred by himself.

Rev. Cornelius Thompson, of Elkesley, near East Retford: for his 1 year and 1 month-old Sow, of a small breed; bred by himself.

*Thomas Wilson, of Shotley Hall, near Newcastle-upon-Tyne: for his 1 year and 1 month-old Sow, of a small breed; bred by himself.

William Ellison, of Sizergh Castle, near Kendal: for his Pen of Three 29 weeks-old Sizergh Breeding Sow-Pigs; bred by himself.

His Grace the Duke of Northumberland, of Alnwick Castle; for his Pen of Three 20 weeks-old Northumberland Breeding Sow-Pigs of a large breed; bred by himself.

*The Right Hon. the Earl of Radnor, of Coleshill House, near Faringdon, Berkshire: for his Pen of Three 23 weeks-old Coleshill breeding Sow-Pigs of a small breed; bred by himself.

[These Commendations are arranged in the order of the numbers of the Certificates to which they refer. The mark (*) signifies "highly commended;" the omission of it, "commended;" by the Judges. Mr. Graham's Boar and Mr. Hobson's Sow were "Very highly Commended."

PRIZES FOR ESSAYS AND REPORTS ON VARIOUS SUBJECTS.

1847.

All Prizes of the Royal Agricultural Society of England are open to general competition.

I. Farming of Northumberland.

Fifty Sovereigns, or a Piece of Plate of that value, will be given for the best Report on the Farming of Northumberland.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The peculiarities of the climate.
3. The improvements effected in the farming of Northumberland since the Report of J. Bailey and G. Culley in the year 1813.
4. The management of the large farms in the north of the county, on the land and at the homestead.
5. The improvements still required in the county generally as to the higher culture of existing farms, the reclamation of waste lands, and the condition of the agricultural labourer.

N.B. The writers of County Reports are requested, if possible, not to exceed the length of 40, or at most of 50 printed pages.

II. Farming of Suffolk.

Fifty Sovereigns, or a Piece of Plate of that value, will be given for the best Report on the Farming of Suffolk.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The management of the land on the various soils.
3. The improvements effected in the farming of Suffolk since the Report of Arthur Young in the year 1804.
4. The antiquity and extent of thorough draining within the county.
5. The process of marling and the soils benefited thereby.

6. The process of burning clay and the soils to which it is applicable.
7. The improvements still required in the county generally as to the higher culture of existing farms, the reclamation of waste lands, and the condition of the agricultural labourer.

III. Farming of Somersetshire.

Fifty Sovereigns, or a Piece of Plate of that value, will be given for the best Report on the Farming of Somersetshire.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The peculiarities of the climate.
3. The course of cropping in the various parts of the county.
4. The history of the general drainage in the various levels, with the improvements still required therein.
5. The dairy management.
6. The management of the orchards.
7. The state of the moor-land district of West Somersetshire.
8. The formation and management of the water-meadows, especially on the hill-sides.
9. Any improvements which have been made since the Report of John Billingsley in the year 1798, and those which are still required.

IV. Management of Wheat.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Report on the Management of Wheat.

Competitors will be required to attend to the following points:—

1. The preparation of the land according to variety of soils.
2. The application of dung or artificial manures.
3. The time of sowing.
4. The quantity of seed.
5. The variety of seed and change of seed.
6. The treatment of the crop in spring as to pressing and hoeing.
7. The diseases to which wheat is liable.
8. The time and mode of cutting.
9. Thrashing and dressing.

V. Beet—(*Mangold Wurzel*).

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Report on the Cultivation of Beet.

Competitors will be required to attend to the following points:—

1. The soils best adapted for beet.
2. The preparation of the land for beet.
3. Manuring.
4. Time and mode of sowing.
5. Varieties of beet.
6. Mode and expense of taking up the crop.
7. Mode of storing.
8. The description of stock to the use of which beet is usually applied, and the advantages of the use of beet as compared with other roots, at the particular time when it is so applied.

VI. Burning of Land for Manure.

Ten Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Burning of Land for Manure.

Competitors will be expected to describe—

1. The character of the soils on which burning is beneficial.
2. The various modes of preparing land for burning.
3. The mode of burning and the expense.
4. The benefit arising from the operation.
5. The injuries which may arise from the abuse of the burning of land.

VII. Flax.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Report on Flax.

Competitors will be expected to state the reasons, general and particular, in favour of extending the growth of Flax in this country, and what are the considerations adverse to the practice. They will likewise be expected to explain in detail the most approved methods of cultivating the plant, the best mode of saving the crop and preparing the flax for market, and to state in what way the whole or any portion of the seed may be saved with the least injury to the fibre, and how the seed may be most profitably applied by the farmer.

VIII. Management of Sheep.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best account of the Management of Sheep.

Although it is clear that no one breed of sheep can be best suited for all parts of the country, and that consequently the system of management must vary also, it is desirable to ascertain the most approved mode

of managing the best breeds of sheep, and the defects of management which exist in some parts of the country.

Competitors will therefore be expected to describe—

1. The various breeds of sheep.
2. The mode of feeding and folding the store flocks.
3. Management of the lambs.
4. The age at which the sheep fatted, and mode of fatting.
5. Effect of management on the productiveness of the soil.

IX. The Great Level of the Fens, including the Fens of South Lincolnshire.

Fifty Sovereigns, or a Piece of Plate of that value, will be given for the best Report on the Great Level of the Fens, including the Fens of South Lincolnshire.

Competitors will be expected to describe—

1. The history of the general drainage, accompanied with a small plan for publication.
2. The mode and defects of the local drainage.
3. The improvements made in the outfall to sea of the rivers falling into the Wash.
4. The disadvantages arising from the defects still remaining.
5. The general plans by which those defects might be remedied.

X. Manure for Wheat.

Thirty Sovereigns, or a Piece of Plate of that value, will be given for an Account of the best Manure for Wheat compounded of chemical ingredients, to be tried by judges appointed by the Society.

A statement of the ingredients of the manure to be communicated before the prize is awarded.

XI. Manure for Turnips.

Thirty Sovereigns, or a Piece of Plate of that value, will be given for an account of the best Manure for Turnips compounded of chemical ingredients, to be tried by judges appointed by the Society.

A statement of the ingredients of the manure to be communicated before the prize is awarded.

XII. Hop-Fly.

Ten Sovereigns, or a Piece of Plate of that value, will be given by Major Curteis, M.P., for the best account of the hop-fly, and of the means for effecting its destruction or preventing its ravages.

Competitors will be required to state—

1. The natural history of the hop-fly in all its stages.

2. The best remedy against its attacks on the hop-plant, and preventive against its ravages by sowing other seed in hop-gardens, or by other means.
3. Whether it attacks other plants?
4. Whether the disease in the hop-plant called "honey" is occasioned by the hop-fly, or arises from some other cause?

These Essays must be sent to the Secretary, at 12, *Hanover Square, London, on or before March* 1*st*, 1847, *excepting the account of the Manure for Wheat, which must be sent on or before September* 1*st*, 1847.

Contributors of Papers are requested to retain Copies of their Communications, as the Society cannot be responsible for their return.

RULES OF COMPETITION FOR PRIZE ESSAYS.

1. All information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books, or other sources.

2. Drawings, specimens, or models, drawn or constructed to a stated scale, shall accompany writings requiring them.

3. All competitors shall enclose their names and addresses in a sealed cover, on which only their motto, and the subject of their Essay, and the number of that subject in the Prize list of the Society, shall be written.

4. The President or Chairman of the Council for the time being, shall open the cover on which the motto designating the Essay to which the Prize has been awarded is written, and shall declare the name of the author.

5. The Chairman of the Journal Committee shall alone be empowered to open the motto-paper of such Essays, not obtaining the Prize, as he may think likely to be useful for the Society's objects, with a view of consulting the writer confidentially as to his willingness to place such paper at the disposal of the Journal Committee.

6. The copyright of all Essays gaining prizes shall belong to the Society, who shall accordingly have the power to publish the whole or any part of such Essays; and the other Essays will be returned on the application of the writers; but the Society do not make themselves responsible for their loss.

7. The Society are not bound to award a prize unless they consider one of the Essays deserving of it.

8. In all reports of experiments the expenses shall be accurately detailed.

9. The imperial weights and measures only are those by which calculations are to be made.

10. No prize shall be given for any Essay which has been already in print.

11. Prizes may be taken in money or plate, at the option of the successful candidate.

12. All Essays must be addressed to the Secretary, at the house of the Society.

Royal Agricultural Society of England.

1846—1847.

President.

THE EARL OF EGMONT.

Trustees.

Vice-Presidents.

Members of Council.

Secretary.

JAMES HUDSON, 12, *Hanover Square, London.*

Consulting-Chemist—Dr. LYON PLAYFAIR, Museum of Economic Geology, London.
Consulting-Engineer—JOSIAH PARKES, C.E., 11, Great College Street, Westminster.
Seedsmen—Messrs. THOMAS GIBBS & Co., Corner of Halfmoon Street, Piccadilly
Publisher—JOHN MURRAY, 50, Albemarle Street.
Bankers—Messrs. DRUMMOND, Charing-Cross.

Honorary Members.

AUSTRIA, His Imperial Highness the Archduke John of.

BUCKLAND, The Very Rev. WILLIAM, D.D., Dean of Westminster.

CARR, Captain J. STANLEY, Duchy of Lauenburg.

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DAUBENY, CHARLES, M.D., Professor of Rural Economy, University of Oxford.

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HOFMANN, Dr., Professor of Chemistry, Royal College of Chemistry, London.

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LIEBIG, Baron, University of Giessen.

MURCHISON, Sir RODERICK I., K.S.P., President of the Royal Geographical Society.

PLAYFAIR, Dr. LYON, Chemist to the Ordnance.

SOLLY, EDWARD, Professor of Chemistry, Hortic. Society, and Addiscombe College.

SPRENGEL, Dr. CHARLES, Secretary to the Pomeranian Agricultural Society.

STEVENSON, The Hon. ANDREW, Washington.

VAN DE WEYER, M. SYLVIAN, Belgian Minister.

WAY, Professor JOHN THOMAS, Royal Agricultural College, Cirencester.

Royal Agricultural Society of England.

GENERAL MEETING,

12, HANOVER SQUARE, SATURDAY, DECEMBER 12, 1846.

REPORT OF THE COUNCIL.

IN commencing this Report, the Council have no hesitation in stating that not only have facts of important practical bearing been obtained through the agency of the Society, from the varied localities of the kingdom, and again made known through the pages of the Journal to its Members residing in every district throughout the country, but a spirit of inquiry on the best means of effecting agricultural improvements has been excited, both in individuals who have extensive opportunities of carrying out their views, and in Local Associations already established for agricultural objects, through which the amount of experience has been increased, and a firmer foundation laid for more secure advancement. Experiment has been actively at work, both in testing the accuracy of reported facts and ascertaining for further application the conditions under which they have occurred, as well as in furnishing suggestions for new modes of practice, to be again submitted to the same strict practical investigation of condition and occurrence.

For the purpose of obtaining new and important facts, the Council, in addition to the Prizes of the Society for Reports and Essays on various subjects, have been enabled, through the liberality of the Duke of Northumberland, the Marquis of Downshire, and Major Curteis, M.P., to enlarge the offer of its premiums. For the attainment of the same end by distinct research,

they have concluded a satisfactory arrangement for an experimental investigation into the relation existing between the composition of the ashes of a plant and the fixed elements essentially required to be present in the manure or soil in which it is grown; and the first report, by Professors Way and Ogston, of the Royal Agricultural College of Cirencester, will appear in the forthcoming part of the Journal. In the communication of information, the Council have not only made every increased exertion, at no inconsiderable expense, to facilitate the transmission of the Journal to the various Members of the Society, but have enlarged the opportunities afforded by Lectures and Discussions for the elucidation or illustration of subjects of a practical and scientific character. The Lectures of Professor Johnston and Mr. Parkes, at Newcastle, and the Discussions to which they gave rise, formed a new and most successful feature in the Annual Country Meeting of the present year, held at that place.

The Council were so well satisfied with the result of the first trial of a discussion on the questions of practical interest and personal experience connected with agriculture at Newcastle, that they have resolved to make arrangements for a similar opportunity for the interchange of opinion on such topics, under similar regulations.

The Society has this year, in the course of its prescribed circuit, held its Country Meeting in the district comprised of the northern counties of England, and remote from the localities of former years; but they have the satisfaction of recording, that in every point of view the Newcastle Meeting has been a most successful one, not only in the fine exhibition of Stock and the trial of Implements, but in the opportunity which it has afforded the Members of the Society of experiencing the hearty welcome and the lively participation of the Farmers of that district in the common object of their mutual interest. To Dr. Headlam, the Mayor, and the members of the Corporation; to Sir Matthew Ridley, the Chairman, and the Members of the Local Committee; and to all the other individuals and public bodies in Newcastle and its neighbourhood, who had laid the Society

under deep obligation by their zealous and efficient co-operation, the Council have had the grateful task of returning their unqualified thanks.

In consequence of parties having in many instances made entries for the Society's Shows and subsequently failed to send their stock or implements so entered, the Council have found it requisite to agree to the following rule, for the purpose of prevention :—

"That for the purpose of checking the entry of cattle and implements, which are not intended to be exhibited, a fine of 10*s*. per head for beasts and horses, and 10*s*. per pen for sheep or pigs, and 5*s*. for implements under, or 10*s*. for those of the price of 10*l*. or upwards, be charged on every animal or pen of animals, or implement entered and not exhibited, unless a certificate shall be sent to the Secretary on or before the day of exhibition, that the non-exhibition is caused by unavoidable accident. And that the Director and Stewards of the Yard be requested to report the names of the parties who have not exhibited as entered at the Show, or neglected to pay the fines."

The Council have also resolved to discontinue the Sale by Auction in the Show-yard at the Country Meetings of the Society.

The Journal Committee have reported during the past half-year, the following adjudication of prizes for Essays, namely—

To George Phillips, analytical Chemist to the Excise, the prize of Fifty Sovereigns, on the Duke of Northumberland's foundation, for the best Essay on the Remedy for the Potato Disease, and on its treatment in the various stages of planting, growth, and preservation.

To Henry Cox, of Longford's House, Minchinhampton, the prize of Twenty Sovereigns, on the Duke of Northumberland's foundation, for the second best Essay on the same subject.

To F. J. Graham, of Cranford, near Hounslow, the prize of Thirty Sovereigns, on the Duke of Northumberland's foundation, for the best history of the Disease at the present time affecting the Potato, involving a condensed detail of facts developed by experiments.

To Hugh Raynbird, of Bury St. Edmund's, the prize of Twenty

Sovereigns for the best Essay on Peat Charcoal as a manure for turnips and other crops.

To Wm. Pyle Taunton, of Ashley, near Stockbridge, Hants, the prize of Ten Sovereigns for the best account of the St. John's-Day Rye.

The Council have accepted the liberal offer of the Marquis of Downshire to add 30*l.* to the sum of 20*l.* already voted by the Society for the best Essay on the Cultivation and Management of Flax, to be sent to the Secretary on or before the 1st of March, 1847.

The Finance Committee have reported that during the past half-year 302 new Members have been elected, 56 have died, and 789 have been struck off the list by order of the Council; and the Society now consists of—

Life Governors	89
Annual Governors	201
Life Members	587
Annual Members	5532
Honorary Members	20
	6429

Of the above 789 Members whose names have been expunged, 519 are those of Members whose subscriptions for the years 1841 and 1842 have remained unpaid on the books of the Society for the last four years, and are still undischarged. Their names have been struck off the list of the Society by order of the Council, on the special recommendation of the Finance Committee.

The Committee have also presented the following statement of the arrears of subscription, made up to the first day of the present month.

Amount of arrears due for—

1843	£456
1844	911
1845	1520
1846	2488
	£5375

Of the amount of the arrears for 1846, nearly one-half has been discharged during the last ten days.

They have also reported that the capital of the Society invested in the public funds stands at 7000*l.* stock, and that the current cash balance in the hands of the Society's bankers on the 1st inst. was 1395*l.*

The Auditors will lay before the Members the Half-yearly Balance-sheet of Accounts as audited by them on the part of the Society.

In filling up the vacancy in the list of Trustees, occurring through the lamented decease of Mr. Handley, by the unanimous election of Lord Portman to that office, the Council have recorded on their minutes an expression of their deep sense of the severe loss the Society has sustained in the removal from its Councils of one so intimately connected with its existence and establishment as one of its founders.

In conclusion, the Council beg to congratulate the Members on the increasing usefulness of the Society, and on its steady progress in the prosecution of those national objects for which it was founded. They feel, however, that it is only by the individual interest and co-operation of its numerous Members, each within his local sphere, in carrying out its practical views, that its vigour and vitality can be efficiently maintained. And they repeat the invitation to the Members at large, to favour the Council not only with their attendance at the Weekly Meetings in London, and at the Meetings in the Country, but also from time to time with such practical suggestions and communications of interesting facts connected with the various topics of agricultural improvement as may promote both the objects of the Society and the public good.

By order of the Council,

(Signed) JAMES HUDSON,
Secretary.

London, Dec. 9, 1846.

General Meetings of 1847.

The GENERAL MAY MEETING, in London, on Saturday, May 22, 1847.

THE ANNUAL COUNTRY MEETING, at Northampton, in 1847: the principal day of the Show being Thursday, the 22nd of July.

The GENERAL DECEMBER MEETING, in London, on Saturday the 11th of December, 1847.

COTTAGE ECONOMY.—Mr. Main's article on Cottage Gardening, and Mr. Burke's compilation on Cottage Economy and Cookery, have each been reprinted from the Journal in a separate form, for cheap distribution. Either or both of these tracts may be obtained by members at the rate of 1*s.* per dozen copies, on their enclosing to the Secretary a Post-office money-order for the number required; at the same time stating the most eligible mode of conveyance by which the copies can be transmitted to their address. They are also sold to the public at 2*d.* each, by the Society's Publisher, Mr. MURRAY, 50, Albemarle Street, London.

VOLUMES OF THE JOURNAL.—The first Volume of the Journal consists of *four* parts, the second and third Volumes of *three* parts each (the second and third parts of the third Volume being comprised in a double number), and the fourth of *two* parts. The Journal is now published half-yearly, namely, the first half-volume for each year about the beginning of July, and the second about the end of December or beginning of January.

SUBSCRIPTIONS may be paid to the Secretary, in the most direct and satisfactory manner, either personally at the Society's office (No. 12, Hanover Square, London), or by means of Post-office orders, to be obtained on application at any of the principal Post-offices throughout the kingdom, or of cheques drawn on London Bankers; such orders or cheques being made payable to the Secretary. They are due in advance, for each year, on the 1st of January; and are in arrear if unpaid by the 1st of June ensuing. No Member is entitled to the Journal, or to any other privileges of the Society, whose subscription is in arrear.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Half-yearly Account ending 30th June, 1846.

Receipts.	£.	s.	d.
Balance in the hands of the Bankers, 1st January, 1846	769	2	5
Ditto in the hands of the Secretary, 1st January, 1846	14	12	9
Dividends on Stock	110	8	8
Sale of Stock	1174	10	0
Life Compositions of Members	372	0	0
Annual Subscriptions of Governors	747	10	0
Annual Subscriptions of Members	2666	12	10
Sale of Journal	139	10	2
Sale of Cottage Tracts	3	3	1
Receipts during the half-year on account of the Country Meetings	4	5	9
Payment made in error by Messrs. Child & Co. to Messrs. Drummond	45	0	0
	£6016	15	8

Payments.	£.	s.	d.
Permanent Charges	270	12	6
Taxes and Rates	21	8	2
Establishment Charges	935	12	10
Postage and Carriage	27	5	6
Advertisements	13	5	0
Expenses of Journal	1568	7	10
Prizes	260	0	0
Payments during the half-year on account of the Country Meetings	296	1	7
Subscriptions repaid	11	6	0
Miscellaneous Payments	6	19	3
Repayment to Messrs. Child & Co. of sum paid in error	45	0	0
Balance in the hands of the Bankers, 30th June, 1846	2564	17	10
Ditto in the hands of the Secretary, 30th June, 1846	25	19	2
	£6016	15	8

(Signed) EGMONT, *President.*
PH. PUSEY, *Trustee.*
THOMAS AUSTEN, *Chairman of Finance Committee.*
THOMAS RAYMOND BARKER, C. B. CHALLONER, HENRY BLANSHARD, } *Members of Finance Committee.*

(Signed) C. H. TURNER, CHAS. TAWNEY, THOMAS KNIGHT, } *Auditors on behalf of the Society.*

Annual Country Meeting of 1847,

TO BE HELD AT

NORTHAMPTON,

IN THE DISTRICT COMPRISING THE COUNTIES OF BEDFORD, BERKS, BUCKINGHAM, HERTFORD, HUNTINGDON, NORTHAMPTON, OXFORD, AND WARWICK.

THE PRINCIPAL DAY OF THE SHOW WILL BE THURSDAY, THE 22ND OF JULY.

THE PRIZES ARE OPEN TO GENERAL COMPETITION.

MEMBERS HAVE THE PRIVILEGE OF A FREE ENTRY, BUT NON-SUBSCRIBERS ARE ALLOWED TO COMPETE, ON THE PAYMENT OF A FEE OF 5*s.* ON EACH CERTIFICATE.

FORMS OF CERTIFICATE TO BE PROCURED ON APPLICATION TO THE SECRETARY, 12, HANOVER SQUARE, LONDON.

ALL CERTIFICATES FOR IMPLEMENTS MUST BE RETURNED, FILLED UP, TO THE SECRETARY ON OR BEFORE THE 1ST OF MAY, AND ALL OTHER CERTIFICATES BY THE 1ST OF JUNE; THE COUNCIL HAVING DECIDED THAT IN NO CASE WHATEVER SHALL ANY CERTIFICATE BE RECEIVED AFTER THOSE DATES RESPECTIVELY.

*** *The usual Auction Sale in the Show-Yard will be discontinued.*

Prizes for Improving the Breed of Cattle.—1847.

SHORT-HORNS.

CLASS

1. To the owner of the best Bull calved previously to the 1st of January, 1845 . . . . . Fifty Sovereigns.
   To the owner of the second-best ditto ditto . Twenty Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1845, and more than one year old . . . . Twenty Sovereigns.
   To the owner of the second-best ditto . . . Ten Sovereigns.
3. To the owner of the best Cow in milk or in calf Twenty Sovereigns.
   [In the case of the cow being in calf, and not in milk, the prize will not be given until she is certified to have produced a calf.]
   To the owner of the second-best ditto . . . Ten Sovereigns.
4. To the owner of the best In-calf Heifer, not exceeding three years old . . . . Fifteen Sovereigns.
5. To the owner of the best Yearling Heifer . . Ten Sovereigns.

HEREFORDS.

CLASS		
1.	To the owner of the best Bull calved previously to the 1st of January, 1845	Fifty Sovereigns.
	To the owner of the second-best ditto ditto . .	Twenty Sovereigns.
2.	To the owner of the best Bull calved since the 1st of January, 1845, and more than one year old	Twenty Sovereigns.
	To the owner of the second-best ditto . . .	Ten Sovereigns.
3.	To the owner of the best Cow in milk or in calf	Twenty Sovereigns.
	[In the case of the cow being in calf, and not in milk, the prize will not be given until she is certified to have produced a calf.]	
	To the owner of the second-best ditto . . .	Ten Sovereigns.
4.	To the owner of the best In-calf Heifer, not exceeding three years old	Fifteen Sovereigns.
5.	To the owner of the best Yearling Heifer . .	Ten Sovereigns.

DEVONS.

1.	To the owner of the best Bull calved previously to the 1st of January, 1845	Fifty Sovereigns.
	To the owner of the second-best ditto ditto . .	Twenty Sovereigns.
2.	To the owner of the best Bull calved since the 1st of January, 1845, and more than one year old	Twenty Sovereigns.
	To the owner of the second-best ditto . . .	Ten Sovereigns.
3.	To the owner of the best Cow in milk or in calf	Twenty Sovereigns.
	[In the case of the cow being in calf, and not in milk, the prize will not be given until she is certified to have produced a calf.]	
	To the owner of the second-best ditto . . .	Ten Sovereigns.
4.	To the owner of the best In-calf Heifer, not exceeding three years old	Fifteen Sovereigns.
5.	To the owner of the best Yearling Heifer . .	Ten Sovereigns.

CATTLE OF ANY BREED:

Not qualified to compete in the foregoing Classes.

(Cross-bred Animals will be excluded.)

1.	To the owner of the best Bull calved previously to the 1st of January, 1845	Twenty-five Sovs.
	To the owner of the second-best ditto ditto . .	Ten Sovereigns.
2.	To the owner of the best Bull calved since the 1st of January, 1845, and more than one year old	Fifteen Sovereigns.
3.	To the owner of the best Cow in milk or in calf	Fifteen Sovereigns.
	[In the case of the cow being in calf, and not in milk, the prize will not be given until she is certified to have produced a calf.]	

CLASS		
4.	To the owner of the best In-calf Heifer, not exceeding three years old	Ten Sovereigns.
5.	To the owner of the best Yearling Heifer . .	Ten Sovereigns.

Horses.

1.	To the owner of the best Stallion for Agricultural purposes, of any age	Forty Sovereigns.
	To the owner of the second-best ditto ditto .	Fifteen Sovereigns.
2.	To the owner of the best three-years-old ditto .	Fifteen Sovereigns.
3.	To the owner of the best two-years-old ditto .	Fifteen Sovereigns.
4.	To the owner of the best Mare and Foal for Agricultural purposes	Twenty Sovereigns.
	To the owner of the second-best ditto . . .	Ten Sovereigns.
5.	To the owner of the best two-years-old Filly .	Ten Sovereigns.

SHEEP.

Prizes for Improving the Breed of Sheep.—1847.

Leicesters.

1.	To the owner of the best Shearling Ram . .	Forty Sovereigns.
	To the owner of the second-best ditto . . .	Fifteen Sovereigns.
2.	To the owner of the best Ram of any other age .	Thirty Sovereigns.
	To the owner of the second-best ditto . . .	Fifteen Sovereigns.
3.	To the owner of the best pen of Five Shearling Ewes	Twenty Sovereigns.
	To the owner of the second-best ditto ditto .	Ten Sovereigns.

South-Down Sheep.

1.	To the owner of the best Shearling Ram . .	Forty Sovereigns.
	To the owner of the second-best ditto . . .	Fifteen Sovereigns.
2.	To the owner of the best Ram of any other age .	Thirty Sovereigns.
	To the owner of the second-best ditto . . .	Fifteen Sovereigns.
3.	To the owner of the best pen of Five Shearling Ewes	Twenty Sovereigns.
	To the owner of the second-best ditto ditto . .	Ten Sovereigns.

Long-woolled Sheep:

Not qualified to compete as Leicesters.

1.	To the owner of the best Shearling Ram . .	Forty Sovereigns.
	To the owner of the second-best ditto . . .	Fifteen Sovereigns.
2.	To the owner of the best Ram of any other age .	Thirty Sovereigns.
	To the owner of the second-best ditto . . .	Fifteen Sovereigns.
3.	To the owner of the best pen of Five Shearling Ewes	Twenty Sovereigns.
	To the owner of the second-best ditto ditto . .	Ten Sovereigns.

Pigs.

Class		
1.	To the owner of the best Boar of a large breed .	Fifteen Sovereigns.
	To the owner of the second-best ditto ditto . .	Five Sovereigns.
2.	To the owner of the best Boar of a small breed.	Fifteen Sovereigns.
	To the owner of the second-best ditto ditto . .	Five Sovereigns.
3.	To the owner of the best breeding Sow of a large breed	Ten Sovereigns.
4.	To the owner of the best breeding Sow of a small breed	Ten Sovereigns.
5.	To the owner of the best pen of three breeding Sow-Pigs of a large breed, of the same litter, above six and under twelve months old. .	Ten Sovereigns.
6.	To the owner of the best pen of three breeding Sow-Pigs of a small breed, of the same litter, above four and under ten months old . .	Ten Sovereigns.

Cheese.

To the exhibitor of the best Hundred weight of Cheese (of any kind) made within the District	Ten Sovereigns.
To the exhibitor of the second-best ditto . . .	Five Sovereigns.

PRIZES FOR AGRICULTURAL IMPLEMENTS.

The Prizes are open to general competition; Members having the privilege of a free entry; while non-subscribers are allowed to compete on the payment of a fee of 5*s.* on each certificate. There will be no sale by auction in the Show-yard.

1847.

Forms of Certificate to be procured on application to the Secretary, 12, *Hanover Square, London. All Certificates must be returned, filled up, to the Secretary, on or before the First of May; the Council having decided, that in no case whatever shall any Certificate for Implements be received after that date.*

Prizes.

For the Plough best adapted to heavy land . . . Ten Sovereigns.

For the Plough best adapted to light land . . . Ten Sovereigns.

For the best Drill for general purposes, which shall possess the most approved method of Distributing Compost or other manures in a moist or dry state, quantity being especially considered . . . . . Fifteen Sovereigns.

[Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.]

For the best Turnip Drill on the flat, which shall possess the most approved method of Distributing Compost or other manures in a moist or dry state, quantity being especially considered . . . . Ten Sovereigns.

[Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.]

For the best Turnip Drill on the ridge, which shall possess the most approved method of Distributing Compost or other manures in a moist or dry state, quantity being especially considered . . . . . Ten Sovereigns.

[Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.]

For the best Scarifier . . . . Ten Sovereigns.

For the best Chaff-cutter . . . . Ten Sovereigns.

For the best Machine for making Draining Tiles or Pipes for agricultural purposes. Specimens of the Tiles or Pipes to be shown in the Yard: the price at which they have been sold to be taken into consideration, and proof of the working of the

Machine to be given to the satisfaction of the Judges	Twenty-five Sovs.
For the best Harrow	Five Sovereigns.
For the best Drill Presser depositing Manure and Seed	Ten Sovereigns.
For the best Churn	Five Sovereigns.
For the best Weighing Machine, for live Cattle and Farm Produce generally	Ten Sovereigns.
For the best and most economical Steaming Apparatus for general purposes	Ten Sovereigns.
For the best Skim or Paring Plough	Five Sovereigns.
For the best Subsoil Pulverizer	Ten Sovereigns.
For the best Horse Seed-Dibbler	Fifteen Sovereigns.
For the best Linseed-Crusher	Five Sovereigns.
For the best One-Horse Cart	Ten Sovereigns.
For the best Thrashing Machine applicable to Horse or Steam-power	Twenty Sovs.
For the best and most economical Set of Tools and Instruments for Draining purposes—	
1. For laying Pipes in Clay	Five Sovereigns.
2. For laying Pipes in Friable Land . .	Five Sovereigns.
3. For General Draining	Five Sovereigns.
For the best Portable or Fixed Steam Engine, applicable to Thrashing, and other Agricultural purposes	Fifty Sovereigns.
For the most approved Model of a Permanent Rick-yard, regard being had to economy, durability, and protection from vermin. *Given by the President*	Twenty-five Sovs.
For the best Drain-Plough to cut out at one, two, or three cuts, to the greatest depth, with not more than four horses, so as to prepare a drain so far for deeper cutting (*including* 10*l.* *added by Mr. Slaney*)	Twenty-five Sovs.
For the best Plough to fill in the soil cast out of drains, with not more than 4 horses (two and two abreast), and not to exceed 5*l.* in cost. *Given by Mr. Slaney*	Ten Sovereigns.
For the best Corn-dressing Machine	Fifteen Sovs.
For the set of Harness best adapted for Agricultural purposes	Five Sovereigns.
For the best Gorse-Bruiser	Ten Sovereigns.
For the best Implement for distributing pulverized Manures broad-cast	Ten Sovereigns.
For the best Grinding-mill for breaking Agricultural Produce into fine meal	Fifteen Sovs.
Miscellaneous Awards	Ten Sovereigns.
For the invention of any new Implement, such sum as the Council may think proper to award.	

PRIZES FOR ESSAYS AND REPORTS ON VARIOUS SUBJECTS.

1847.

All Prizes of the Royal Agricultural Society of England are open to general competition.

I. Farming of Northumberland.

Fifty Sovereigns, or a Piece of Plate of that value, will be given for the best Report on the Farming of Northumberland.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The peculiarities of the climate.
3. The improvements effected in the farming of Northumberland since the Report of J. Bailey and G. Culley in the year 1813.
4. The management of the large farms in the north of the county, on the land and at the homestead.
5. The improvements still required in the county generally, as to the higher culture of existing farms, the reclamation of waste lands, and the condition of the agricultural labourer.

N.B. The writers of County Reports are requested, if possible, not to exceed the length of 40, or at most of 50 printed pages.

II. Farming of Suffolk.

Fifty Sovereigns, or a Piece of Plate of that value, will be given for the best Report on the Farming of Suffolk.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The management of the land on the various soils.
3. The improvements effected in the farming of Suffolk since the Report of Arthur Young in the year 1804.
4. The antiquity and extent of thorough-draining within the county.
5. The process of marling and the soils benefited thereby.

6. The process of burning clay, and the soils to which it is applicable.
7. The improvements still required in the county generally, as to the higher culture of existing farms, the reclamation of waste lands, and the condition of the agricultural labourer.

III. Farming of Somersetshire.

Fifty Sovereigns, or a Piece of Plate of that value, will be given for the best Report on the Farming of Somersetshire.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The peculiarities of the climate.
3. The course of cropping in the various parts of the county.
4. The history of the general drainage in the various levels, with the improvements still required therein.
5. The dairy management.
6. The management of the orchards.
7. The state of the moor-land district of West Somersetshire.
8. The formation and management of the water-meadows, especially on the hill-sides.
9. Any improvements which have been made since the Report of John Billingsley in the year 1798, and those which are still required.

IV. Management of Wheat.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Report on the Management of Wheat.

Competitors will be required to attend to the following points:—

1. The preparation of the land according to variety of soils.
2. The application of dung or artificial manures.
3. The time of sowing.
4. The quantity of seed.
5. The variety of seed and change of seed.
6. The treatment of the crop in spring as to pressing and hoeing.
7. The diseases to which wheat is liable.
8. The time and mode of cutting.
9. Threshing and dressing.

V. Beet—(*Mangold-Wurzel*).

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Report on the Cultivation of Beet.

Competitors will be required to attend to the following points:—

1. The soils best adapted for beet.
2. The preparation of the land for beet.
3. Manuring.
4. Time and mode of sowing.
5. Varieties of beet.
6. Mode and expense of taking up the crop.
7. Mode of storing.
8. The description of stock to the use of which beet is usually applied, and the advantages of the use of beet as compared with other roots, at the particular time when it is so applied.

VI. Burning of Land for Manure.

Ten Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Burning of Land for Manure.

Competitors will be expected to describe—

1. The character of the soils on which burning is beneficial.
2. The various modes of preparing land for burning.
3. The mode of burning and the expense.
4. The benefit arising from the operation.
5. The injuries which may arise from the abuse of the burning of land.

VII. Flax.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Report on Flax.

Competitors will be expected to state the reasons, general and particular, in favour of extending the growth of Flax in this country, and what are the considerations adverse to the practice. They will likewise be expected to explain in detail the most approved methods of cultivating the plant, the best mode of saving the crop and preparing the flax for market, and to state in what way the whole or any portion of the seed may be saved with the least injury to the fibre, and how the seed may be most profitably applied by the farmer.

The Marquis of Downshire will add £30 to this Prize.

VIII. Management of Sheep.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best account of the Management of Sheep.

Although it is clear that no one breed of sheep can be best suited for all parts of the country, and that consequently the system of management must vary also, it is desirable to ascertain the most approved mode

of managing the best breeds of sheep, and the defects of management which exist in some parts of the country.

Competitors will therefore be expected to describe—

1. The various breeds of sheep.
2. The mode of feeding and folding the store flocks.
3. Management of the lambs.
4. The age at which the sheep fatted, and mode of fatting.
5. Effect of management on the productiveness of the soil.

IX. The Great Level of the Fens, including the Fens of South Lincolnshire.

Fifty Sovereigns, or a Piece of Plate of that value, will be given for the best Report on the Great Level of the Fens, including the Fens of South Lincolnshire.

Competitors will be expected to describe—

1. The history of the general drainage, accompanied with a small plan for publication.
2. The mode and defects of the local drainage.
3. The improvements made in the outfall to sea of the rivers falling into the Wash.
4. The disadvantages arising from the defects still remaining.
5. The general plans by which those defects might be remedied.

X. Manure for Wheat.

Thirty Sovereigns, or a Piece of Plate of that value, will be given for an Account of the best Manure for Wheat compounded of chemical ingredients, to be tried by judges appointed by the Society.

A sealed statement of the ingredients of the inorganic manure which the competitor proposes to employ, along with the particulars of quantity and price, must be addressed under cover to the Secretary. Subsequent information as to the mode of trial will be forwarded to the competitors.

XI. Manure for Turnips.

Thirty Sovereigns, or a Piece of Plate of that value, will be given for an account of the best Manure for Turnips compounded of chemical ingredients, to be tried by judges appointed by the Society.

A sealed statement of the ingredients of the inorganic manure which the competitor proposes to employ, along with the particulars of quantity and price, must be addressed under cover to the Secretary. Subsequent information as to the mode of trial will be forwarded to the competitors.

XII. Hop-Fly.

Ten Sovereigns, or a Piece of Plate of that value, will be given by Major Curteis, M.P., for the best account of the hop-fly, and of the means for effecting its destruction or preventing its ravages.

Competitors will be required to state—

1. The natural history of the hop-fly in all its stages.
2. The best remedy against its attacks on the hop-plant, and preventive against its ravages by sowing other seed in hop-gardens, or by other means.
3. Whether it attacks other plants?
4. Whether the disease in the hop-plant called "honey" is occasioned by the hop-fly, or arises from some other cause?

These Essays must be sent to the Secretary, at 12, *Hanover Square, London, on or before March* 1*st*, 1847, *excepting the account of the Manure for Wheat, which must be sent on or before September* 1*st*, 1847.

Contributors of Papers are requested to retain Copies of their Communications, as the Society cannot be responsible for their return.

RULES OF COMPETITION FOR PRIZE ESSAYS.

1. All information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books, or other sources.

2. Drawings, specimens, or models, drawn or constructed to a stated scale, shall accompany writings requiring them.

3. All competitors shall enclose their names and addresses in a sealed cover, on which only their motto, and the subject of their Essay, and the number of that subject in the Prize list of the Society, shall be written.

4. The President or Chairman of the Council for the time being, shall open the cover on which the motto designating the Essay to which the Prize has been awarded is written, and shall declare the name of the author.

5. The Chairman of the Journal Committee shall alone be empowered to open the motto-paper of such Essays, not obtaining the Prize, as he may think likely to be useful for the Society's objects, with a view of consulting the writer confidentially as to his willingness to place such paper at the disposal of the Journal Committee.

6. The copyright of all Essays gaining prizes shall belong to the Society, who shall accordingly have the power to publish the whole or any part of such Essays; and the other Essays will be returned on the application of the writers; but the Society do not make themselves responsible for their loss.

7. The Society are not bound to award a prize unless they consider one of the Essays deserving of it.

8. In all reports of experiments the expenses shall be accurately detailed.

9. The imperial weights and measures only are those by which calculations are to be made.

10. No prize shall be given for any Essay which has been already in print.

11. Prizes may be taken in money or plate, at the option of the successful candidate.

12. All Essays must be addressed to the Secretary, at the house of the Society.